EARLY DIAGNOSIS OF CHRONIC SIMPLE GLAUCOMA BY VARIOUS OCULAR PARAMETERS WITH SPECIAL REFERENCE TO GOLDMANN KINETIC PERIMETRY AND APPLANATION TONOMETRY

THESIS

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1984

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CERTIFICATE

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A C K N O W L E D G E M E N T

Today, when I pick up my pen to express my heartfelt thanks to all those, who helped me realize what I consider so dear, I have no dearth of feelings but only an understanding of the futility of my expression. For, I am sure, I can never manage to bringforth my sincere gratitude towards all who have meant so much in the formation of this project. Yet I shall try.

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INTRODUCTION

INTRODUCTION

Whereas clinical research work in glaucoma was often touched with speculation and fantasy 50 years ago, today we are disposed to look pragmatically at the problem of early diagnosis. Still interest in derivation of word glaucoma continues. The term glaucoma has been claimed to be derived from Greek word 'GLAUKOS' meant basically 'Blue' and word glaucoma evolved from the idea that blue eyed animal have poor vision by day. It was said to have been coined by Aristotle to refer to weakness of vision in day light (Ballintine, 1969). While others believe it to be derived from 'GLAUKOSIS' meaning sea green. This term was used on account of greenish hue observed in the dilated pupil of elderly persons suffering from glaucoma when examined by kerosene lamp. The term glaucoma does not connote a disease entity; but embraces a composite congeries of pathological conditions which comprise any raised intraocular pressure which the tissues of the particular eye in question are unable to stand without damage to their structure or impairment of normal physiological function. More recently Hayreh (1972) by fluoroangiophotography showed that increase intraocular

pressure probably damages the tissue by influencing the circulation of blood in papilla.

Among the various forms of glaucoma, chronic simple glaucoma still remains one of the principal causes of blindness throughout the world. Usually because of acute symptom complex it is easy to diagnose angle closer glaucoma, contrary to this because of slow course most of the patients suffering from chronic simple glaucoma are diagnosed in late stages when damage to the eye by the disease process has occured and become permanent.

The early diagnosis of chronic simple glaucoma still seems to be quite far from real goal. Although various surveys have been conducted for screening of glaucoma at an early stage, yet because of the varying conditions under which they are performed and various standards adopted for reporting, no two studies are comparable and it is not possible to transfer the result of these statistical surveys to decision making in individual cases. There is definite evidence that if an early and effective control of disease process is obtained, 85% of glaucomatous eyes can maintain good vision throughout the life (Schlesinger, 1965). The efforts to find a

relationship between the raised intraocular pressure and development of a deterioration in visual function by various workers have yielded controversial results. Graham (1968) in 3-4 years prospective study found, out of 232 eyes with raised intraocular tension only one developed field loss and Armaly (1969) noticed out of 198 eyes with initial tension of more than 23 mm Hg. one developed field loss. While Leydhecker (1967) in a 7 years follow up, found 26 out of 50 ocular hypertensive developed field loss and Kitazawa et al (1977) after following 75 patients with ocular hypertension for 9 years noticed field loss in 7 patients. So waiting for scotoma in a person with raised intraocular pressure is a legalistic and not scientific procedure. Clearly a time honoured principle PRIMUM NON NOCERE has been violated, meaning by when there is a great probability of doing more harm than good to patient by any procedure, that procedure must be avoided. Knowing the magnitude of problem this present study has been undertaken to enunciate better norms.

This treatise is a modest attempt towards the realization of this goal.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A knowledge of the earliest stages of damage in a chronic disease process, preferably at a stage when it is still reversible seems fundamental to an understanding and rational management of the disease. In chronic simple glaucoma, which many ophthalmologists will diagnose only when damage to visual function has already occured, it is essential to know the earliest reproducible disturbances and their mode of progression in order to ensure that recognition is not unnecessarily delayed and yet treatment should not be commenced unnecessarily early in all cases of ocular hypertension.

As glaucoma is not a disease SUI GENERIS but a symptomatic condition (Duke elder, 1970), many definitions to define the disease process have been put forward by various ophthalmologists. According to Duke-Elder and Jay (1969) glaucoma does not connote a disease entity but embraces a composite congeries of pathological conditions which comprise any raised intraocular pressure which the tissues of

the particular eye in question are unable to stand without damage to their structure or impairment of normal physiological function and with a diurnal variation of more than 5 m.m. of mercury.

Kolker and Hetherington (1970) define glaucoma by an increased intraocular pressure, excavation and degeneration of optic disc and typical nerve fiber bundle damage, producing defects in field of vision. Any or all of these signs may be present at a given examination.

According to Hayreh (1972) glaucoma is a symptomatic condition in which intraocular pressure is too high for a sufficient circulation of blood to be maintained in the papillae for a continued survival of its tissue.

According to Trevor-Roper (1974) glaucoma, may be defined as a persistent or repeated ocular hypertension which eventually causes pathological changes within the eye. Goldmann (1975) defines glaucoma a disease in which the intraocular pressure is too high for continued maintenance of visual function.

The diagnosis of chronic simple glaucoma depends upon various factors viz, abnormal intraocular tension, definite field loss, cupping of disc, non occludible angle of anterior chamber etc.

TONOMETRY

The raised intraocular pressure has been thought to be one of the main causes of the diminution of visual field ever since simple glaucoma has been recognized as a nosological entity and measurement of ocular tension plays an important role in detection of patients suffering from chronic simple glaucoma.

The various methods of measuring the intraocular pressure are,

(a) Digital tonometry - The impressibility of the ocular coats is estimated by the sense of fluctuation perceived on palpation, so its accuracy is therefore never high and depends entirely on the clinical sense and tactus eruditus of the observer. It is only useful to know gross deviation from normal.

(b) Manometry - Intraocular pressure is measured by a manometer connected to small bore cannula which is

introduced into the anterior chamber. This is the most accurate method. Although good for laboratory purpose yet can not be employed in clinical practice.

(c) Instrumental tonometry - It refers to measurement of impressibility of the tunics of the eye by deforming forces applied to those tunics. The impressibility of these tunics depends on the resistance of the eye ball to these forces and resistance in turn is dependent on the intraocular pressure and rigidity of the coats of eye ball. Thus instrumental tonometry gives a measure, approximate of the intraocular pressure. It is of two types.

(i) Indentation - measures depth of impression produced upon the ocular wall by a given force which is represented by a plunger.

(ii) Applanation - force necessary to flatten a known area of cornea is measured.

INDENTATION TONOMETRY

Many types of impression or indentation tonometers have been devised and a great amount of ingenuity has been expended upon their design.

A brief account of development of various tonometers are as follows :

Year	Inventor	Name of Tonometer	Features
1863	Von Graefe	Graefe tonometer	
1879	Priestley Smith	Similar to Graefe tonometer	
1905	Schiotz	Schiotz tonometer	measures the depth of the impression produced by a given force acting on the turnica of the eye.
1912	Gradle	Gradle tonometer	It is a modified Schiotz tonometer.
1913	Ruben	Ruben tonometer	Similar to Schiotz with a horizontal bar to be used in upright position, has a

1919	William McLean	McLean tonometer	Modified Schiotz type with a simple plunger.
1922	Bodenheimer	Maximum tonometer	
1923	Bailliart	Aneroid tonometer	Ocular tension is recorded by working of a plunger against a standardized spring.
1926	Schiotz	'X' tonometer of 1926.	It has a convex plunger surface instead of concave.
1930	Vogelsang	Ballistic Tonometer.	A complicated method of tonometry depending on photographing the oscillations in the recoil of a minute hammer which is allowed to hit the cornea under standard condition.

1948	J. Sklar	Modified Schiotz	Similar to schiotz except insertion of mirror at the scale to eliminate parallax, also has epicycloid lever system.
1955	Wiegersma	Elastometer	Having a lighter hammer than used by vogelsang.
1959	Maurice	Electronic tonometer	Force necessary for plunger to make a definite indentation is measured and recorded by a mechano-electric transducer.

APPLANATION TONOMETER - Various types of applanatometers are as follows :-

Year	Inventor	Name of Tonometer	Features
1861	Weber	Weber's tonometer	First introduced applanation

			tonometer applying Imbert-Fick law.
1885	Maklakow	-	Area of applanation is measured with a constant force.
1895	Goldwin	-	Calibrated the Maklakow tonometer.
1918	Romer	-	Improved by inserting binocular for reading and dividing image with the help of a prism.
1928	Apin	-	Based on alternative principle of using a variable force to applanate a constant area.
1951	Maurice		
1954	Goldmann		
1960	Mac Kay et al		
1957	Goldmann and Schmidt	Modefied Goldmann	Most commonly used and is based on above principle.
1965	Perkin E.S.		Devised a hand held applanation tonometer employing the same principle as Goldmann

		It does not require a slit lamp and can be used in any position.
1966	Draeger	Similar to Perkin's tonometer.

The normal intraocular pressure denotes both statistical average pressure and pressure which is compatible with uninterrupted health and function of eye. This pressure need not be the same in every eye and instances occur in which the eye suffers in health and function, yet its pressure remains within the usual range (Mehrotra, 1971).

This average intraocular pressure of non glaucomatous population has been studied by various workers. It approximates a Gaussian distribution and may be described in statistical terms (Becker and Shaffer, 1965). By different workers values ranging from 15 to 35 mm have been recorded.

Schiotz (1909) after studying a group of normal population found values ranging from 19 to 30 mm of mercury.

Alimuddin (1956) investigated 1000 eyes (669 male and 331 female) by Schiotz 'X' tonometer. He found average tension to be 19.0 mm of mercury.

Abrahamson and Abrahamson (1959) performed applanation and Schiotz tonometry in 250 normal individuals belonging to 22 to 24 years age group. The normal range was 14 to 24 mm of mercury with a mean average of 18 mm of mercury by both the methods. While Draeger (1959) found a mean value of 14.5 with Goldmann applanation tonometer.

Levene (1961) found a mean value of 15.6 mm of mercury by applanation tonometer.

There is significant difference in reading of schiotz and applanation tonometers. At least two factors seem to take major part, firstly position of the patient, secondarily scleral rigidity. The results of various workers are not akin to each other.

Pahwa (1961) measured intraocular pressure of 311 normal individuals, both by Schiotz and applanation tonometer and mentioned that intraocular pressure measured by applanation technique is 2 mm lower than what obtained with Schiotz in supine position.

Ammaly (1962) in a comparative study of large sample by applanation and Schiotz tonometer found Schiotz reading approximately 1 mm higher than that of applanation. He noted mean intraocular pressure by applanation to be 15.92 mm of mercury while the Schiotz tonometer reading were 16.86 mm of mercury.

Ammaly and Salamoun (1963) compared the applanation reading in horizontal position with Schiotz. There was a poor agreement between two systems of measurement. The Schiotz readings were markedly lower to applanation readings as follows :

Horizontal applanation	17.36 mm ± 0.53
Schiotz reading	15.1 mm ± 0.47

Schwartz and Dee Oao (1966) reported applanation reading averaging 1.1 mm higher than Schiotz when comparing applanation measurement while seated with Schiotz measurement in supine posture. This was based on finding of 502 individuals with normal eyes.

Jackson (1965) did a comparative study of applanation and Schiotz tonometers adding 1 mm to all reading of applanation technique as pressure is higher in recumbent than in the upright position.

He observed that 95% of applanation reading were the Schiotz range ± 0.5 mm.

Becker and Gay (1959) carried out applanation tonometery in the diagnosis and treatment of glaucoma. They observed if the scleral rigidity coefficient is lower than normal, Schoitz measurement with one weight may fail to detect glaucoma or provide false severity as to its status of control; while applanation tonometery reveals the higher intraocular pressure in such eyes and results in an accurate diagnosis. Smith et al (1967) in a co-operative study reported entirely different result. They found consistently higher applanation reading occasionally of a magnitude of 10 to 20 mm of mercury. Bayard (1970) after examining 100 eyes of 54 consecutive patient over 27 years of age both by Schiotz and Goldmann's applanation tonometer found greater agreement between two systems while using 1948 conversion scale of Schiotz. The Schiotz readings were only 0.55 mm lower than the corresponding Goldmann reading.

This was the brief account of the various efforts by different workers to determine the range of normal intraocular pressure, but the epistemological problem of what is normal has not been solved.

Armaly (1965) on studying the intraocular pressure of normal 2327 individuals by applanation tonometer stated that applanation pressure in general population deviates significantly from the Gaussian distribution, enforcing that the statistics of latter will grossly underestimate the prevalence of ocular hypertension. Contrary to this Bechrakis (1970) on basis of 1235 anamnestically healthy eyes has been able to show that intraocular pressure by applanation after transformation, is of normal logarithmic distribution with a high degree of probability.

Findings of Kolker and Hetherington (1976) regarding normal and abnormal pressure are well accepted for any glaucoma screening survey. According to them statistically intraocular pressure above 21 mm of mercury (mean + 2 S.D.) should occur in less than 2.5% of normal population and intraocular pressure of more than 24 mm of mercury (mean + 3 S.D.) in less than 0.15% of normal population, so any pressure above 21 mm of mercury should be taken into suspicion and above 24 mm of mercury is likely to be pathological.

VISUAL FIELDS

It is crucial to know exactly what the early stages and sequences of change of visual field are

in cases of chronic simple glaucoma, so that a definite diagnosis of disease can be given at an early stage. So skillful and thorough examination of the visual field must be the corner stone of any attempt at early detection of chronic simple glaucoma.

The concept of field defects in glaucoma was put forward more than 100 years ago. Von Graefe (1869) was first to describe the paracentral scotoma in the central field in cases of glaucoma. Latter the advent of perimeter shifted the emphasis from paracentral area to periphery until Bjerrum (1889) and his disciple Ronne (1909) reverted to testing of visual field with the use of small stimuli and 2 meters screen. This was named as campimetery. They described enlargement of blind spot as an early field change in chronic simple glaucoma followed by arcuate scotoma with nasal step.

Later on Traquair (1939, 1948) whose painstaking campimetry remains a classic discovered small detached scotomous area above or below the blind spot with small test objects as an early field change.

Aulhorn and Harms (1967) reported that most frequent early field defects in chronic simple glaucoma are circumscribed paracentral scotomas in centre of 30° of visual field.

Drance (1969) carried out a study in a group of people in whom one eye showed the advanced changes of open angle glaucoma and other eye was apparently not damaged to 1 mm/1000 white target. Static and Kinetic perimetry was performed by Tubingen perimeter (a perimeter similar to Goldmann) to plot the photopic visual thresholds at 1° intervals along the oblique meridians. The classical changes in the second eye were found to be small absolute paracentral scotoma with their long axis usually directed in the line of arcuate nerve fibres surrounded by a zone of relative scotoma and separated from the blind spot by completely normal field or very much less disturbed area of visual functions.

Harrington (1971) observed that upper nasal field is more frequently damaged in adult onset glaucoma. Newell (1969) also had similar view.

Armaly (1971) while studying the earliest changes in field of vision in chronic simple glaucoma

found peripheral nasal step and temporal sector shape defects as an early changes.

Le Blanc and Becker (1971) determined the frequency of characteristic peripheral nasal defects with step like features in 51 consecutive patients with primarly open angle glaucoma. Circular static perimetry was done using various size test objects and positive finding were confirmed by meridional static and kinetic perimetry. Out of 81 eyes exhibiting characteristic glaucoma field loss, peripheral nasal field defects with step features were present in 21 (26%) eyes, 12 of which also had a central field defect. Thus these findings attest the importance of isolated peripheral nasal step as an useful diagnostic sign.

Drance and Reid (1972) finding an occasional step, temporal to blind spot; emphasized a need for careful search of this area.

Drance and Werner (1977) studied retrospectively 22 eyes of 22 patients with initially normal visual field in which a field defect developed subsequently. Field were recorded both on kinetic and static perimetry. There were some prior disturbances in 13 out of 22 eyes. These

disturbances consisted either of scatter or minor depression of sensitivity in the area of field where the definite defect subsequently appeared while in a control group only 6 of 22 eyes showed these type of disturbances. These findings were statistically significant (X^2 = 4.539 p $\angle$ .05 fisher exact test 0.033). So they advocated a need for searching of these types of disturbances as an early change in glaucomatous eyes.

Zingirian (1979) by using an original method of kinetic and static analysis examined the nasal visual field of normal and glaucoma suspects. He concluded that a nasal step less than 4° wide with a depth of $\angle$ 0.5 log unit is merely a physiological sign of anatomic and functional asymmetry of the retina while bigger than this is a characteristic glaucomatous field defect, as an isolated scotoma in Bjerrum area. It is easily detectible by kinetic perimetry and can be used as a sensitive marker in early diagnosis and follow up of chronic simple glaucoma.

Werner (1980) stressed the studying of temporal field. In a study of 151 glaucomatous eyes with typical nerve fiber bundle defects he found that 4 (3%) had isolated temporal field defect.

In a prospective evaluation of reliability and efficiency of an optimized visual field screening protocol for glaucoma Rabin et al (1981) tested 145 eyes of 73 patients, with increased intraocular pressure, by Goldmann perimeter using kinetic and suprathreshold static technique. He noticed most common initial defects, in 43 eyes showing glaucomatous defects, were the nerve fiber bundle defect or depression in the region below or above the blind spot (12 eyes i.e. 28%).

Shemer (1982) after examining 20 eyes of glaucoma suspects by Goldmann perimeter using both kinetic and static methods concluded that static perimetry is useful when kinetic perimetry fails to show any change.

Rasai et al (1982) by examining 300 visual fields of 153 consecutive patients who had glaucoma or increased intraocular pressure by Goldmann perimeter, found crowding of peripheral nasal isopter in 65 of the 240 visual fields (21.6%) with a detectable abnormalities.

<u>OPTIC DISC</u>

The phenomenon of the cupping of the optic disc was put forward initially by Jacobson (1853);

Jaeger (1854) with the introduction of ophthalmoscope. The pale cupped disc found in final stages of glaucoma was known to Von Graefe (1854). Since then many workers have described changes that occur in the optic disc in chronic simple glaucoma with particular interest in changes which may occur in the early stages of disease as there is increasing evidence that early cupping is reversible (Elkington, 1975). Pederson and Herschler (1982) also noticed reversal of glaucomatous cupping in six cases after control of intraocular tension.

The decision whether or not the optic disc shows early glaucomatous changes is one that has to be made frequently in clinical practice.

Studies of normal population have shown that while there is a wide diversity in the appearance of the normal optic disc, in a single subject the two discs are remarkably similar. In a group of 500 patients studied by Snydacker (1964) only 15 (3%) showed asymmetrical cups in two eyes. Similar findings were noted by Armaly and Saydegh (1969). In 1000 subjects the cup disc diameter ratio of one eye of an individual varied ± 0.2 or more from that of fellow eye in only 8% of cases.

Fishman (1970) studied a series of 500 normal patient, 160 ocular hypertensive patients and 53 established cases of chronic open angle glaucoma. He found asymmetrical cupping of optic disc in 5.6% of normal individuals, in 30% of the cases with ocular hypertension but without field defects and in 36% cases with established glaucoma. So he stressed that a search for disc asymmetry should be an integrated part of glaucoma screening.

According to Fisher et al (1970) cupping of optic disc is the single most reliable sign in diagnosing simple glaucoma, for it is probable that excavation of disc precedes the development of field defects.

Armaly (1970) studied 83 subjects having PA level of 20 mm or above, a glaucomatous field defects and open angles on gonioscopy. He found in individuals with monocular involvement of visual field, the C/D ratio was larger in the affected eye in 36 subjects. Thus with careful ophthalmoscopic examination, one could have suspected glaucoma on the basis of this inequality in 60% of this group.

According to Weisman et al (1973) a difference in cup-disc horizontal ratio of greater than 0.2 in the two eyes is present in less than 1% of normal individuals but in 16% of patients with bilateral glaucoma and 25% with unilateral glaucoma. They also concluded that when the vertical cup-disc ratio is greater than the horizontal cup-disc ratio by at least 0.2 and the horizontal ratio is more than 0.4 the presence of field loss should be suspected.

Kirsch and Anderson (1973) after examining 70 normal and 80 glaucomatous patients have emphasised the significance of vertically oval cup even if it is small and surrounded by what appears to be rim of healthy tissue.

According to Tomlinson and Phillips (1974) in non glaucomatous subjects the shape of disc influences the shape of physiological cup within it. A vertically oval cup tending to occur in vertically oval disc.

Gloster (1975) after examining 130 normal eyes (31 non glaucomatous, 78 ocular hypertensive and 20 fellow eyes of unilateral glaucoma) and 86 eyes with glaucomatous field defects found that

ratio expressing the ovalness of cup was less than 1.0 in non glaucomatous eyes, indicating that the physiological cup is on an average, horizontally oval, the ratio slightly exceeds 1.0 in eyes with raised tension but no field defects, whether those were in patients with ocular hypertension or were the fellow eyes of patients with unilateral simple glaucoma. When a field defect could be established the mean ratio increased to 1.2. These results, thus, strongly support the view that an early change in glaucomatous disc is vertical elongation of the cup.

In a study conducted by Elkington (1975), he found that discs with cup area of more than 60% were highly susceptible to damage by glaucoma.

Hitching and Spaeth (1977) after examining stereoscopic photograph of disc of 504 eyes from 252 patients found that glaucomatous field defect can be predicted in 82% of glaucoma cases on the basis of disc-cup appearance.

According to Drance (1978) in majority of patients who developed field defects, early abnormality of disc probably precedes disturbances in the visual field so an observed change, in the

architecture or colour or both of the optic nerve head, is a reliable sign of glaucoma. He also stated that asymmetry of the neuroretinal rim of two optic nerves occurs rarely in normal population and when associated with raised intraocular pressure should constitute strong evidence of acquired tissue change.

In a study undertaken by Sharma and Chaturvedi (1982) in 105 cases with disc cup asymmetry 15 cases (14.3%) were found to be glaucomatous on first visit, while 72 cases (68.5%) were proved to be glaucomatous on subsequent visit thus making the glaucomatous group of 87 cases (82.8%), indicating asymmetry of cup as an important diagnostic tool.

MATERIAL AND METHODS

MATERIAL AND METHODS

The subjects in this study were the patients attending the out patient department of Ophthalmology and also those who were admitted to Ophthalmology wards of M.L.B. Medical College and Hospital, Jhansi between May, 1982 to March, 1983. This study was undertaken on a series of 60 subjects to see the relationship of various ocular parameters in early diagnosis of chronic simple glaucoma. A subject was considered in study if he/she was falling in one of the following groups :-

* Group I
* Group II

GROUP I :

A person on routine examination showing intraocular pressure of 21 mm of mercury or more by Goldmann applanation tonometer (Sitting).

GROUP II :

Fellow eyes of the patients suffering from unilateral chronic simple glaucoma.

A series of sixty patients, belonging to above chosen groups, was examined on the following lines.

HISTORY :

Detailed history of ocular complaints alongwith family history and also regarding various systemic diseases like diabetes, hypertension, cardiovascular disorders and use of any medication was recorded on a preset proforma.

EXAMINATION :

1. Systemic examination : A general examination of various systems was done and any positive finding, if found, was noted in the proforma.

2. Local examination : It was done with the help of Diffuse illumination, Focal illumination and Slit lamp examination. The state of the anterior segment of the eye was noted and special attention was given to exclude any recent or past sign of inflammation and to record the depth of anterior chamber and if sign of any ocular disease was found

that case was excluded from the study.

Besides these investigations, various other examinations were also undertaken, which are listed below :-

(a) Visual acuity.
(b) Pupillary examination.
(c) Intraocular pressure recording.
(d) Gonioscopy.
(e) Fundus examination.
(f) Perimetry.
(g) Campimetry.

(a) VISUAL ACUITY :

Visual acuity of every patient was recorded initially and in subsequent follow ups. The distant visual acuity was recorded with the help of Snellen's distant chart (Snellen, 1862) and near vision was recorded by standard reading test types as recommended by British Faculty of Ophthalmologists (Law, 1951). After doing the retinoscopy (static & dynamic) corrected visual acuity for near and distant was also noted.

(b) EXAMINATION OF PUPIL :

Pupils of both eyes were seen for :-

(1) Pupillary reaction.

(2) Size of pupil.

(1) Pupillary reaction : Direct and consensual pupillary reactions were seen with the help of a spot light. Reaction to accomodation was also noted. Special attention was paid to presence of Gunnsign.

(2) Size of pupil : This was measured by the reticule of telescope attached to Goldmann's perimeter. After placing patient on the Goldmann's perimeter chin and head rest normal required background luminosity of sphere (31.5 asb) was obtained by adjustable device. Now the patient's eye was centred and focused and diameter of pupil was noted in millimeters by reticule scale. The other eye was also subjected to the same procedure.

(c) MEASUREMENT OF INTRAOCULAR PRESSURE :

The intraocular pressure or tension was recorded with the help of Goldmann's applanation tonometer attached to a Haag-Streit-900 slit lamp.

Intraocular pressure was recorded at various hours of day and highest reproducible reading was taken.

As applanation tonometer is not in routine use at various institutes, a brief description of the instrument will not be out of scope of this study.

Goldmann's applanation tonometer :-

It is the most commonly used tonometer in clinical research and works on Imbert-Fick law by this force necessary to flatten a known area of cornea is recorded. It consists of a plexiglass plate, 7.0 mm in diameter, at one end of a cylinder, which is used to applanate an area of cornea 3.06 mm in diameter. The plate is made to press on the cornea by a coiled spring and lever system of very great stability. The force employed over the coiled spring is controlled by a drum calibrated directly in mm. This gives a force that may vary between 0 and 7 gms. This whole instrument is mounted on a Haag Streit-900 slit lamp. The corneal area flattened is observed with right ocular of microscope. The measurement of the flattened

surface is made directly on the cornea. Between the plate and the observer there is a pair of prism so as to divide the circular field into two halves and displace them 3.06 mm apart. A force of 1 gm placed on a surface of F = 7.345 mm^2, its diameter being 3.06 mm, corresponds to a pressure of 10 mm of mercury.

Method of recording tension :

(1) Preparing the patient :-

- Both eyes of the patient were anaesthetised with 2-3 drops of 4% topical xylocaine within 30-40 seconds.

- A sterile fluorescein paper strip (here Hang Streit A.G. sterile fluorescein strips were used)was placed near the outer canthus in the lower conjunctival sac in the same manner as for the Schirmer test. After few seconds when the lacrimal fluid was sufficienty coloured, the paper strip was removed.

- Now the patient was asked to put his/her head on the chin and forehead rest of the slit lamp.

(2) Preparing the slit lamp and tonometer :-

- Pressure arm with the prism was then swinged into the beam of the light of the slit lamp along the axis of right microscope.

- After opening the slit apperture fully, the blue filter was brought into light beam of slit lamp. The angle between microscope and illuminating device was set at 60^{0}. The switch was set at 6 volts or more if needed.

- Right microscope was focused on the front surface of the prism so that fluorescein ring could be seen distinctly.

- Now the measuring drum was set at 1 gm.

(3) Instruction to patient :-

- Patient was asked to press head firmly against the chin and forehead rest (For this, if necessary head rest band was also used).

- He or she was asked to blink immediately before taking the measurement so as to get cornea moist by lacrimal fluid with fluorescein.

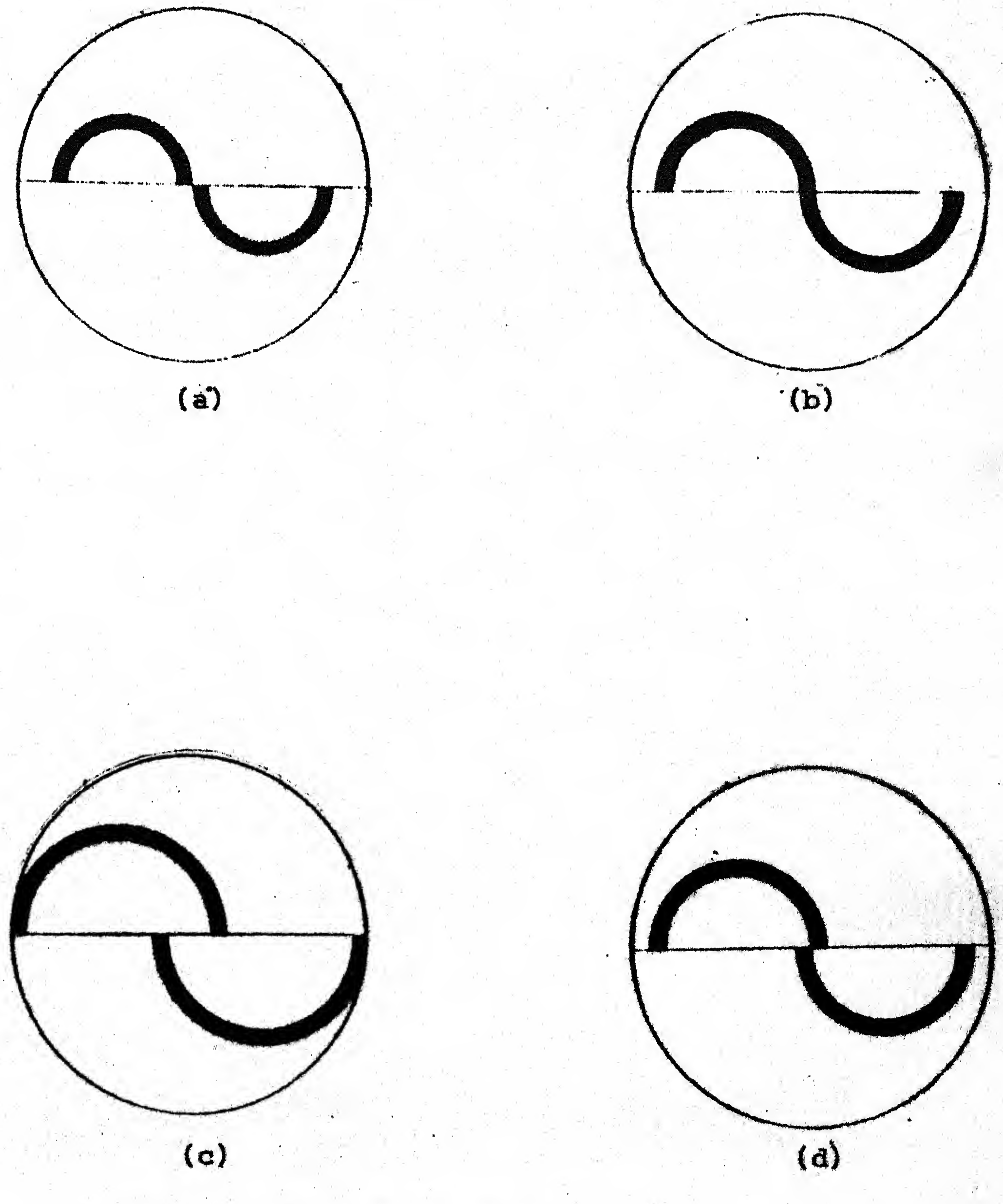
- Patient was asked to look straight ahead if necessary fixation lamp was also used.

- Now the patient was asked to keep his/her eye wide open. If necessary it was held open without putting any pressure over the eye ball.

(4) Measurement :-

- Slit lamp was moved forward to bring the prism into contact of cornea on pulpillary area. As soon as the limbus lighted up, Slit lamp's forward movement was stopped.

- Now the two semicircles were looked through the right ocular of microscope, so as to steady the pulsation of two fluorescein semicircles of equal size in the middle of the field of view (Fig 3). If it was not like this adjustment was done with the help of height control and joy stick.



(a) (b)

(c) (d)

a-b - Pressure is low

c - Pressure is high

d - Correct final position

FIG - 3 CORRECT AND INCORRECT POSITION OF FLUORESCEIN RINGS.

- The pressure on the eye was increased by turning the measuring drum on the tonometer until the inner border of the two fluorescein rings just touched each other (Fig 3). The width of the fluorescein band around the point of contact should be about 0.3 mm.

- Pressure applied by the measuring drum was noted. This multiplied by 10 was the intraocular pressure in mm of mercury.

- This first reading was taken as trial and subsequently 3 readings were taken and if they remained within a range of ± 0.5 mm, they were considered correct.

NOTE : In case of spherical corneal curvature, measurement was made in any meridian preferably in 0 meridian while in cases of astigmatism of more than 3.0 diopter measurement was made in a direction of 45^0 to least power.

(d) GONIOSCOPY :

Biomicroscopic examination of anterior chamber angle was performed with the help of

Goldmann's 3 mirror gonioscope. The method used was as follows :-

- The conjuctival sacs of the patient both eyes was anaesthetised with 4% topical xylocain.

- Now the goniolens hollow was filled with Moisol.

- While the patient was looking up, the inferior margin of the gonioscope was placed into the lower cul-de-sac and then, slowly, it was placed over the eye ball.

- Patient was seated on the slit lamp.

- By focusing the slit and rotating the gonioscope all the four quadrants were examined.

- Grading of the anterior chamber angle was done according to Kolker and Hetherington classification (1976).

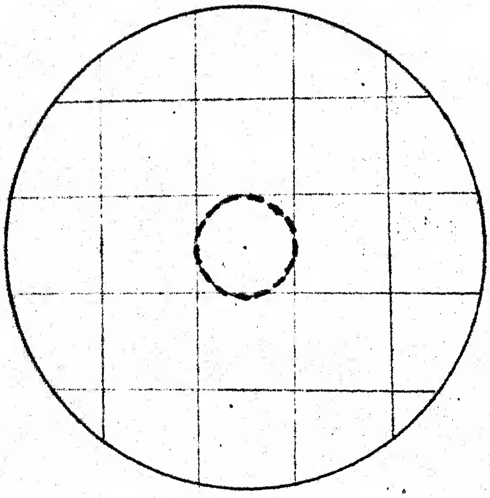
(e) FUNDUS EXAMINATION :

Fundus examination of the both eyes was done with the help of direct ophthalmoscope. If pupils were small they were dilated by instilating 10% Phenylephrine (DROSYN), preceding to this angle was examined with gonioscope. The state of cup and disc along with vessels was seen in detail. This was drawn on the chart based on Shaffer and coworkers method (1975). A brief description of that is as follows :-

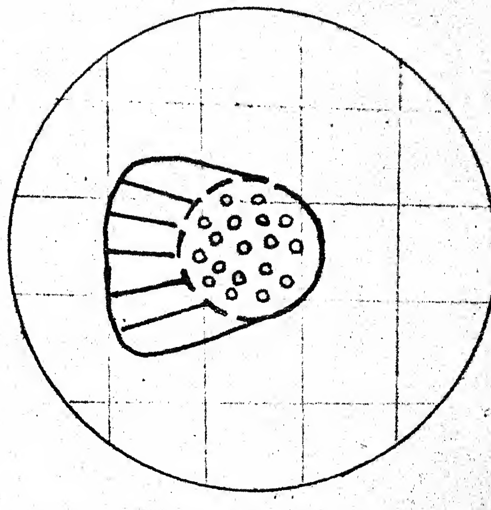
In this two circles representing the outside diameter of each disc were divided into squares of 0.2 disc diameter each. The cup/disc ratio was then expressed in tenth of disc diameter (Fig 4).

In diagramming the disc an inner circle was drawn representing one's best estimate of interface between neurons and the lamina cribrosa as identified by the pinkness to pallor ratio. A solid line was used to represent vertical or undermined edge of cup while a dashed line for sloping edge.

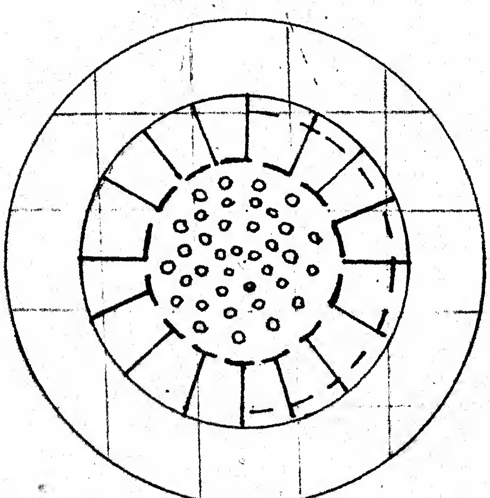
A second peripheral circle inside the disc margin was used to show where nerve fibers



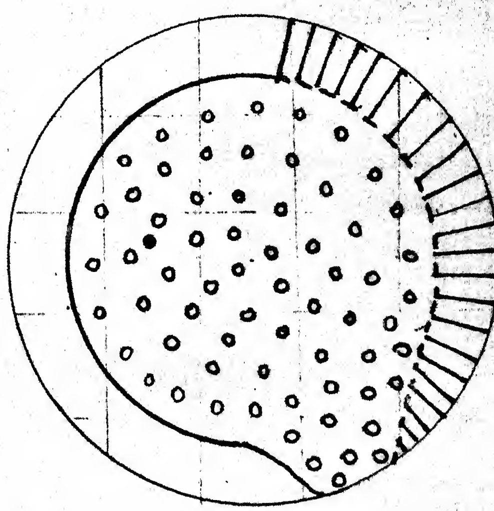
(a) C/D ratio 0.2, small cup with sloping border, lamina cribrosa not exposed.



(b) C/D ratio 0.3, deeper cup exposing lamina cribrosa. Nerve fibre reaching upto periphery of disc.



(c) C/D ratio 0.4 with an upward slope to the retinal level near the edge of disc. On one side slope steepens abruptly as shown by short concentric line.



(d) C/D ratio 0.8 with exposed lamina cribrosa with loss of nerve fibre at 5 O'clock.

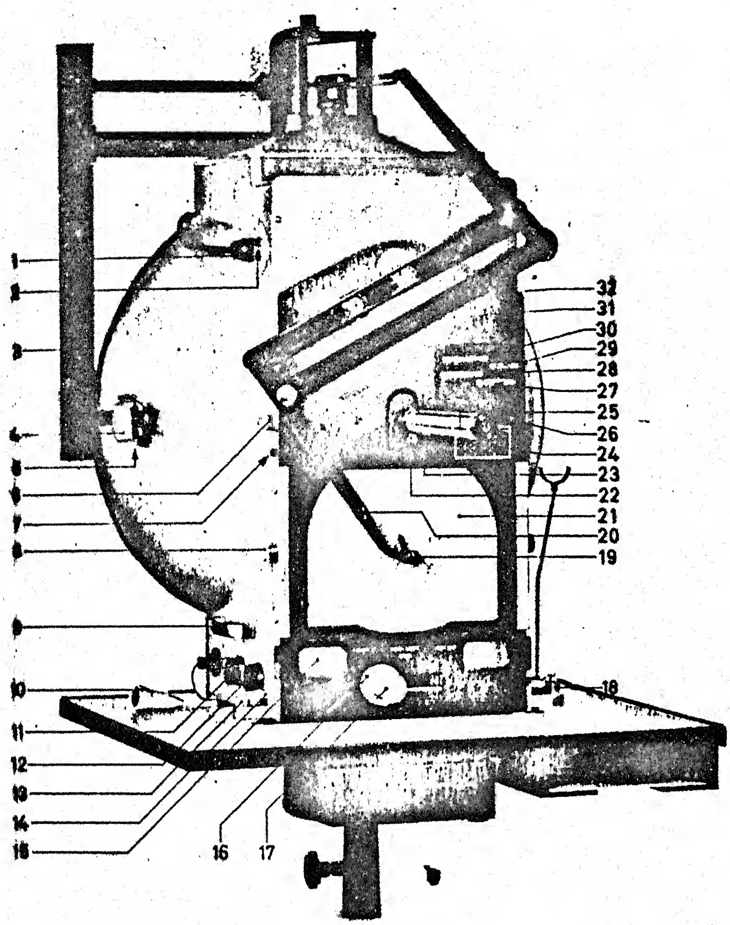
FIG 4 SHAFFER AND COWORKER'S METHOD OF DISC DIAGRAMMING

reach the approximate level of surrounding retina. The steepness of the slope was shown by the several radial lines between the inner and out circles. Areas of increased slope were shown by concentric dashes to radial lines and if lamina cribrosa was exposed it was shown by tiny circle (Fig 4). Where ever needed fundus photographs were taken with the help of Zeiss Fundus camera.

(f) FIELD CHARTING :

(a) Peripheral field (Kinetic quantitative perimetry):-

The fields were taken by using Goldmann perimeter - 940 Haag Streit A.G. It is a spherical projection perimeter with a recording device. It consists essentially of a hollow hemispherical circumscribed bowl which is of 300 mm radius. Inner surface of this is painted matt white. A nitralamp illuminates the inner of the bowl. This is shadded from the rest of the hemisphere by a hood. A portion of light is sent by a condenser through a hollow lever arm containing the projection system for the perimeter target. By this means, slight variations in the brightness of the lamp affect background and target luminosity equally.



1 Socket with cable for main bulb
2 Left-hand socket for central scotoma device
3 Projector
4 Lightmeter
5 Handle for photometer screen
6 Bulb for illumination of the lightmeter scale
7 Push-button contact for 6
8 Knurled knob for chart plate
9 Handle
10 Push-contact with cable for buzzer signal
11 Resistance for main bulb
12 Resistance for chart illumination
13 Spirit level
14 Foot screws
15 Slide in front of bulbs for chart illumination
16 Knurled knob for lateral movement of the head-res
17 Knurled knob for vertical movement of the chin-re
18 Plug device for holder of correcting lenses
19 Handle of pantograph
20 Pantograph coupling
21 Chart plate
22 Tightening screw for telescope
23 Handle for large fixation point
24 Table for filter combinations on 940-K7
25 Telescope
26 Checking aperture
27 Lever for diaphragms
28 Handle for normal grey filters 940-K7
29 Handle for grey filters 940-ST
30 Handle for additional grey filters 940-K7
31 Centring socket
32 Centring pin

FIG - 5 GOLDMANN PERIMETER

The movement of the projection arm is produced by a pentograph controlled by a handle which slides on a vertical plate of opalglass illuminated from behind, intensity of which can be adjusted by a resistance. On the back of the perimeter, this plate has a place for recording chart, which is secured in place by four pressure clips. Each position of handle corresponds exactly with the position of the spot of light on the hemisphere. By slow movement of the handle across the surface of chart the visual field may be examined for 95° on each side of fixation. A telescope through the back of the hemisphere allows for constant observation and control of patient eye fixation. In it lies a light, variable sized, fixation point. The back side of the sphere has a four sets of levers meant for controlling the size of target and intensity. These projected targets are ellipses of varying sizes from 1/16 mm^2 to 64 mm^2 while series of neutral filters permits geometric reduction in the luminosity of target from 100 millilamberts to 3.16 millilamberts. Usually basic luminosity of the target has been fixed at 33 times that of background. This is adjusted by lightmeter and photometer. This whole hollow sphere is mounted on a platefoam which can be moved up and

down by a device. On patient's side there lies a chin and forehead rest with head band. This can be moved up and down and side to side with help of two knobs. It also has a buzzer signal for immediate response. This whole instrument is mounted in a dark and quiet room.

METHOD :

(A) Adjusting the perimeter : The instrument was levelled by turning both foot screw no. 14 until sprit leveles 13 showed correct position.

Chart was inserted over the chart plate by turning the Knurled nobs 8 and was positioned in such a manner that line 'e' on its botton edge was in the V notch of the frame and two lateral 'g' marks with level of two lateral V notch (Fig 6).

Refraction of patient was done previously and optimum correction was given for a distance of 30 cm. If patient was in presbyopic group (usually present), addition to distance correction was done as follows :-

35-40 years old + 1.0 D sph.

40-45 years old + 1.5 D sph.

45-50 years old + 2.0 D sph.

50-55 years old + 2.5 D sph.

55-60 years old + 3.0 D sph.

Over sixties + 3.25 D sph.

After switching on the power supply of the perimeter patient was placed infront of the perimeter in a perfectly comfortable position.

The other eye of the patient was covered with opal occluder and chin and forehead rest was adjusted after placing the patient and he/she was told about the whole procedure in detail.

Perimeter was gauged first with the lightmeter, then with the photometer screen in the following manner.

The index at the end of the pantograph was guided to the little circle at 70° on the right hand side of the chart. (Point h in Fig 6) Centring pin 32 was pressed to lock the pantograph. Now by using the largest and brightest target (Levers 27 to 30 towards the extreme right position)

normal luminosity of 1000 asb or 1430 lux was obtained by resistance 11. To obtain 31.5 asb luminosity of sphere, handle 5 was pulled downwards, putting the white photometer screen in the light path of target, and grey filter 0.0315 was interposed by using lever 28. Now looking through the telescopic aperture and by moving sliding diaphragm up or down, sphere brightness was adjusted to that of photometer screen.

After centring the patient's eye looking through the telescope, patient was asked to maintain fixation and to use buzzer if he or she was able to see the target coming from periphery to centre.

Now sitting on the otherside with eye at the level of telescope width of the pupil was measured by millimeter scale of telescope and was recorded on chart.

Then the examination was done by target size I and intensity 4 (I/4e) subsequently with I/2e,I/1e. Special attention was given to nasal step or presence of any scotoma.

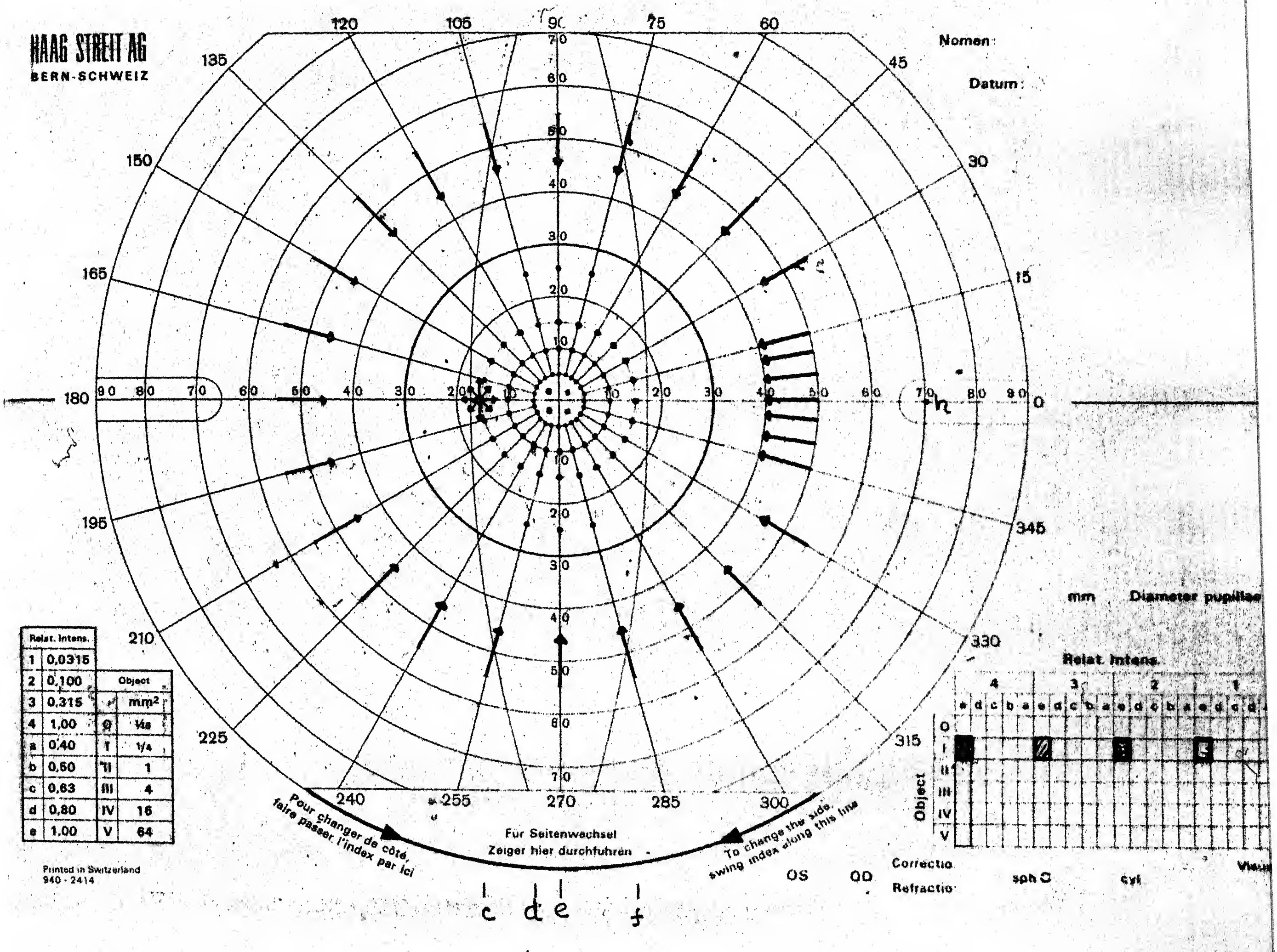


FIG - 6 ARMALY'S METHOD OF KINETIC GOLDMANN PERIMETRY

Blind spot was then plotted with I/1 or I/2 using shutter control 33.

Paracentral scotomas were examined by means of flashing with I/1 or 0/1.

Entire field was examined on basis of Armaly's method for glaucomatous defects (Armaly, 1972).

(g) Campimetry (central field charting with Bjerrum tangent screen) :

After the peripheral field had been investigated the central area of field (30° from fixation point) was examined by a Bjerrum tangent screen.

It consists of square matt black cloth of 2x2 meters. At the centre of it lies a matt white disc of about 10 mm diameter to be used as fixation points. The screen is calibrated by no obviously visible black silk marking in meridians every 10° and in concentric circles every 5°. It was illuminated with the help of day light lamps.

Patient was seated in front of the target screen at distance of 2 meters in such a manner that eye to be examined was exactly opposite the fixation mark. Patient with steadied head in the above position, the other eye being occluded, was asked to maintain fixation. Now the entire 30° of central field was examined by Traquair's target. Starting with 2 mm object if needed bigger object was used. Special care was given to localise the blind spot or any scotoma.

Fig. 1 APPLANATION TONOMETER

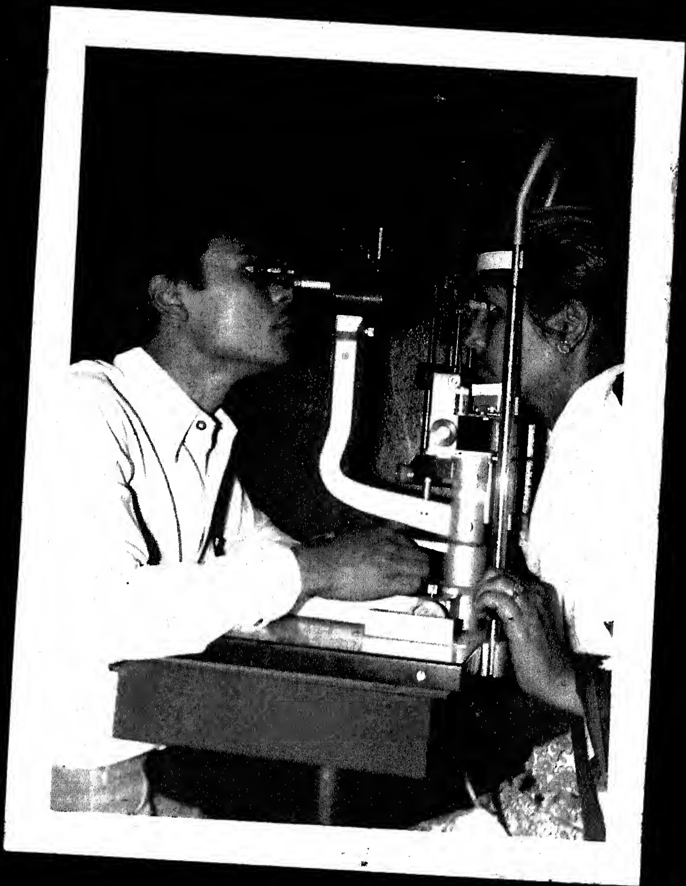


Fig. 2 APPLANATION TONOMETER IN USE

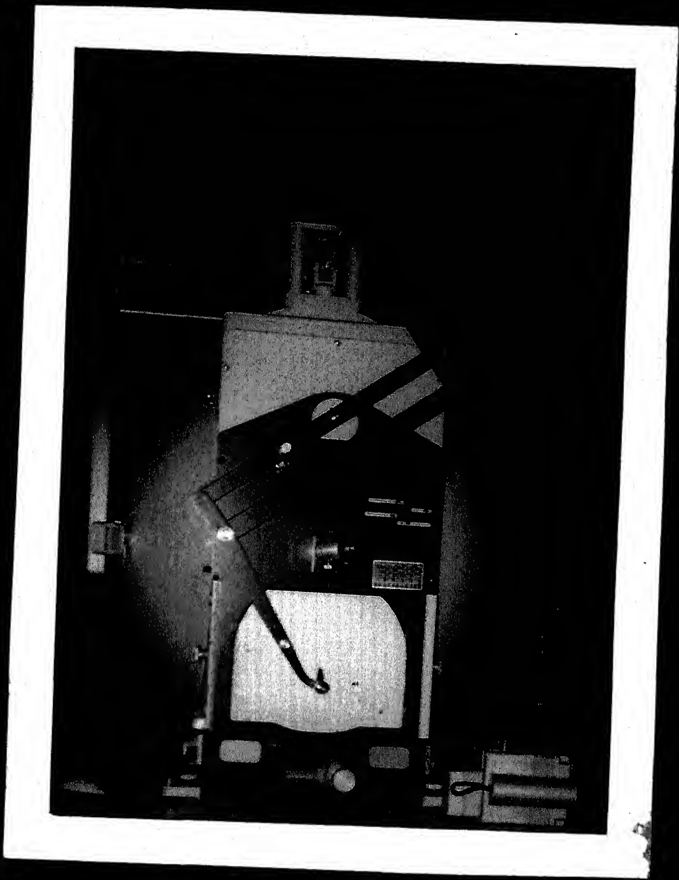
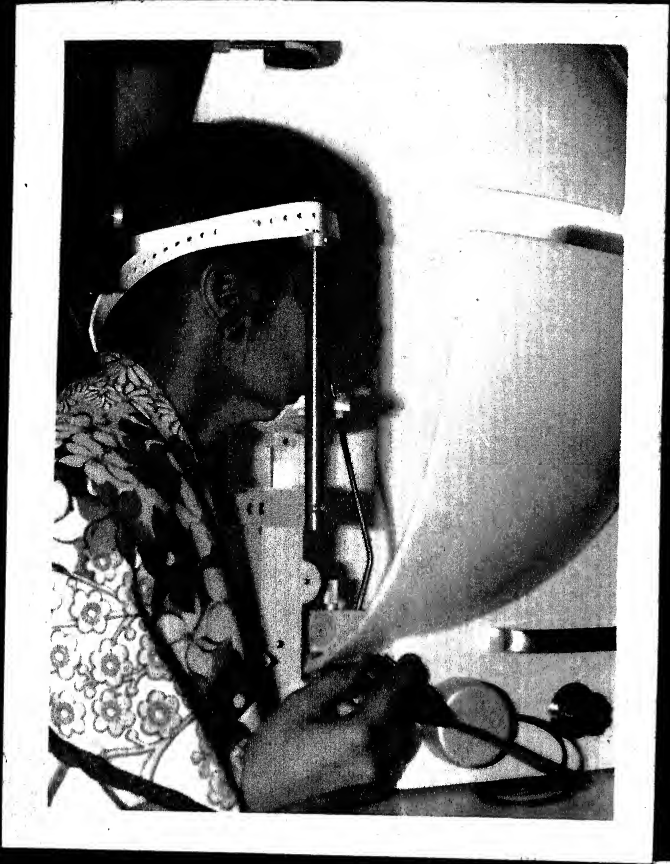


Fig. 5b GOLDMANN PERIMETER



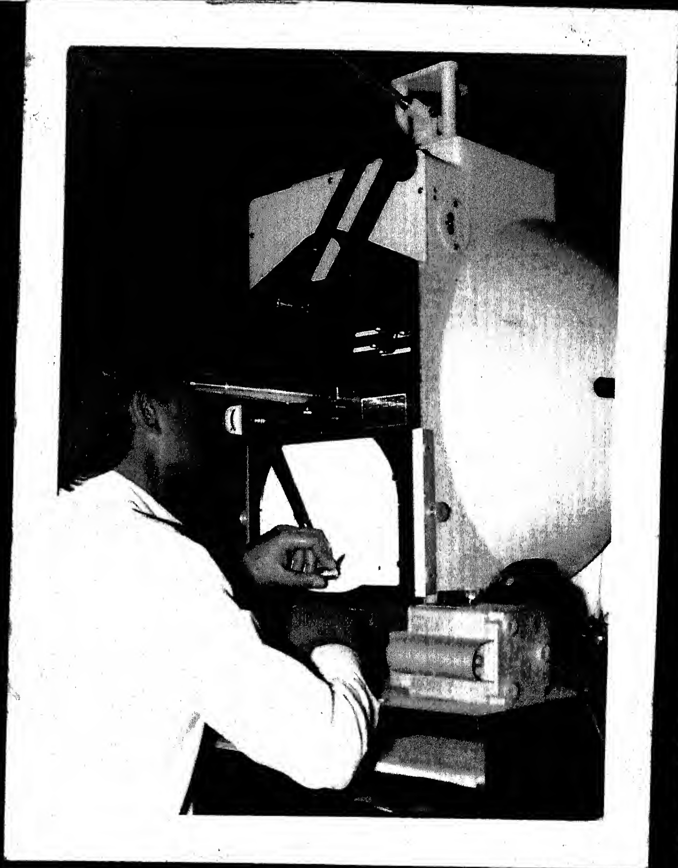


Fig. 7 GOLDMANN PERIMETER IN USE

O B S E R V A T I O N S

O B S E R V A T I O N S

This study was conducted on the patients attending Ophthalmology department of M.L.B. Medical College and Hospital, Jhansi for their ocular complaints during the period from May, 1982 to March, 1983. A series of 72 patients of either sex was examined initially, out of which 12 patients were excluded from the study because of poor co-operation. This study was aimed to find out better norms for early diagnosis of chronic simple glaucoma by various ocular parameters. Each subject was grouped according to his/her mode of presentation into the following groups (details given earlier).

Group I Patients having intraocular pressure 21 mm of mercury or more, 50 patients (83.33%) belonged to this group (Table 1, Fig. 9).

Group II Fellow eye of patient suffering from unilateral chronic simple glaucoma, 10 patients (16.67%) were in this group (Table 2).

So the main bulk of the patients was from the group I i.e. ocular hypertension group (Table 1).

TABLE 1

DISTRIBUTION OF PATIENTS INTO VARIOUS GROUPS

	Male	Female	Total	
			No.	%
Group I	26	24	50	83.33
Group II	7	3	10	16.67
Total	33	27	60	100.00

The following table (Table 2) shows age distribution of patients. Approximately 60% of the patients falled between 35 to 54 years. The mean age of total patients was 45.66 $\pm$ 11.52 years. So the patients were from the presbyopic group. There was no significant difference between mean age of male and female patients. The mean age of male was 46.57 years as to 44.13 years of female. The number of male patients slightly exceeded from that of female with a male/female ratio of 1:0.818 (Fig. 10).

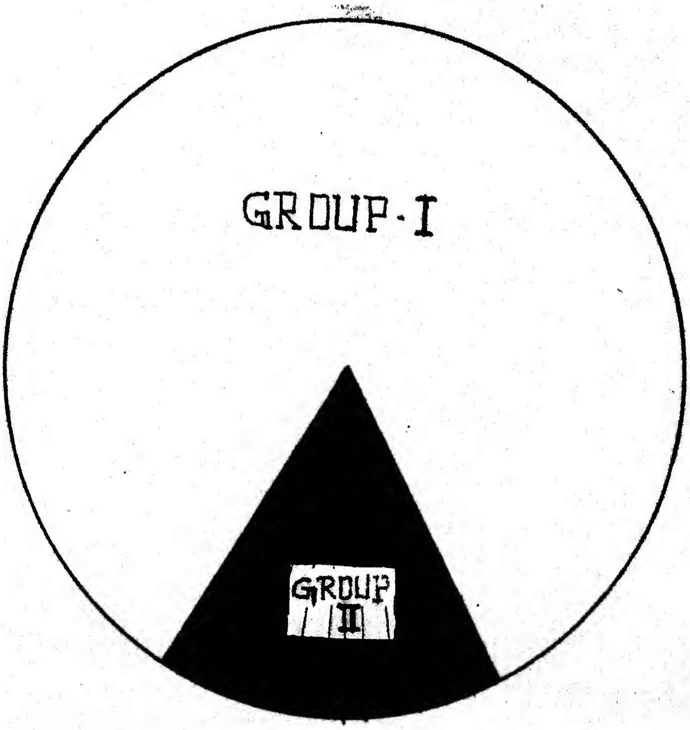


FIG. 9 PROPORTION OF CASES AMONG GROUP I and II.

TABLE 2

DISTRIBUTION OF PATIENTS BY AGE AND SEX

Age groups in years	Male		Female		Total	
	No.	%	No.	%	No.	%
25 - 34	3	09.09	8	29.63	11	18.33
35 - 44	14	42.43	6	22.22	20	33.33
45 - 54	8	24.24	9	33.33	17	28.33
55 - 64	6	18.18	2	07.41	8	13.33
65 - 74	2	06.06	1	03.70	3	05.00
75 and above	-	-	1	03.70	1	01.68
Total	33	100.00	27	100.00	60	100.00

Mean age in years ± S.D. = 45.66 ± 11.52

Mean age of male and female groups = 46.57 and 44.13 respectively.

Male/female ratio 1 : 0.818

Percentage of male and female in total population = 55 % and 45% respectively.

The main presenting complaint of the patients (78.33%) was diminution of vision (Fig. 11). On further investigations of the patients presenting with diminution of vision 47 cases (78.33%) were found to be having defective near vision and 31 cases (51.67%) were with defective distant vision. Several cases presented with both near and distant defective vision. However, distant as well as near vision improved after eliminating refactive errors in 96.66% of cases with defective distant vision and in 95.0% of cases with defective near vision. Thus almost every individual had normal vision (Table 3, 4 & 5).

TABLE 3

CLASSIFICATION OF PATIENTS BY PRESENTING COMPLAINTS

Presenting complaint	Male	Female	Total No.	Total %
Diminution of vision.	27	20	47	78.33
Other complaints	6	7	13	21.67
Total	33	27	60	100.00

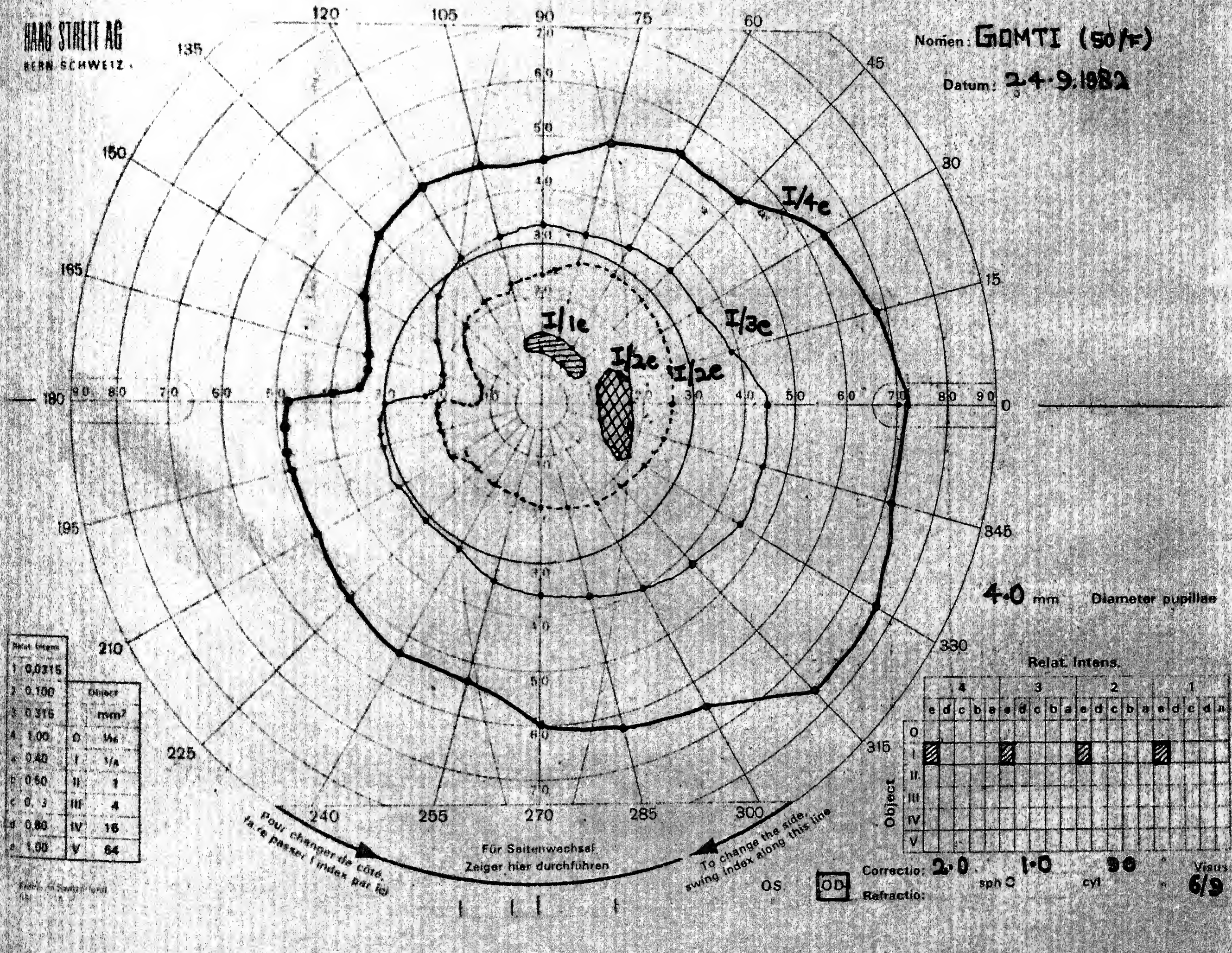


FIG - 8 GOLDMANN KINETIC QUANTITATIVE PERIMETRY SHOWING -

a. NASAL STEP (BY I/4e, I/3e & I/2e TARGETS)
b. ENLARGE BLIND SPOT (BY I/2e TARGET)
c. PARACENTRAL SCOTOMA (BY I/1e TARGET)

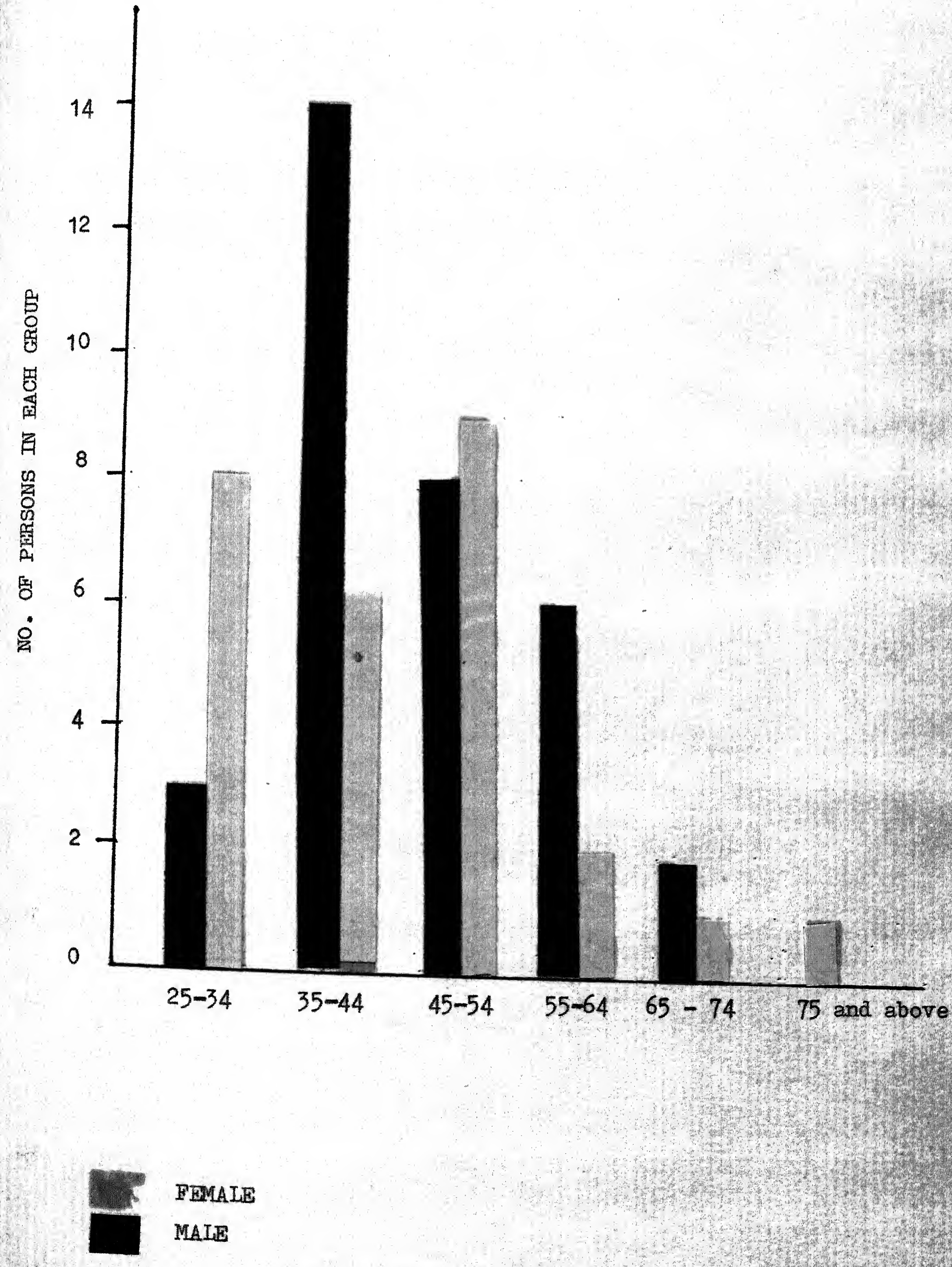


FIG - 10 DISTRIBUTION OF PATIENTS ACCORDING TO AGE AND SEX

TABLE 4

DISTRIBUTION OF PATIENTS BY UNCORRECTED VISION (NEAR AND DISTANT)

	Vision			
	Distant		Near	
	No.	%	No.	%
Normal*	29	48.33	13	21.67
Below normal	31	51.67	47	78.33
Total	60		60	

*Vision of 6/9 or better in worst eye.

Figure in parenthesis indicates percentage.

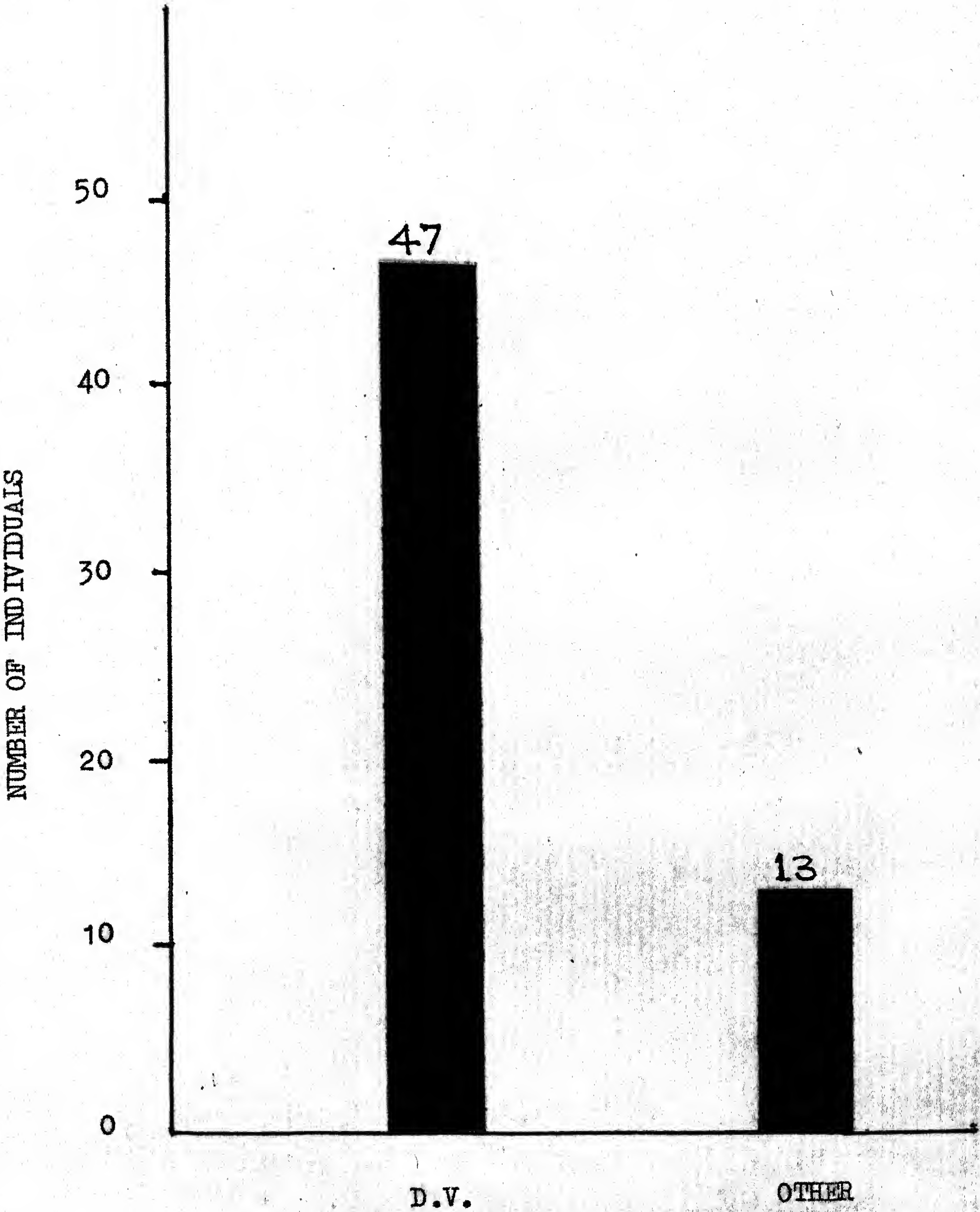
TABLE 5

DISTANT AND NEAR VISION (CORRECTED)

	Distant		Near	
	No.	%	No.	%
Normal*	58	96.66	57	95.0
Below normal	2	3.34	3	5.0
Total	60		60	

*Vision of 6/9 or better in worst eye.

Figure in parenthesis indicates percentage.



D.V. = DIMINUTION OF VISION (NEAR)

FIG - 11 DISTRIBUTION OF PATIENTS ACCORDING TO CHIEF PRESENTING COMPLAINTS.

TABLE 6

NUMBER OF EYES WITH NORMAL AND RAISED INTRAOCULAR TENSION

Intraocular tension (By Applanation)	Right Eye	Left Eye	Total	
			No.	%
NORMAL ($\angle$ 21 mm Hg)	8	8	16	13.33
RAISED (21 mm of Hg or above)	52	52	104	86.67
Total	60	60	120	100.00

Table - 6 shows number of eyes who had ocular hypertension. Out of 120 eyes examined 104 eyes (86.67%) had intraocular tension 21 mm of Hg or more while in the rest 16 eyes (13.33%) an intraocular tension of less than 21 mm of Hg was recorded by Goldmann applanation tonometer. Most of the eyes from this group were fellow eyes of unilateral chronic simple glaucoma cases.

TABLE 7

DISTRIBUTION OF EYES BY INTRAOCULAR TENSION

I.O.P.groups in mm Hg. (By Applanation)	Right Eyes	Left Eyes	Total Eyes	%
15 - 17	3	4	7	5.83
18 - 20	5	4	9	7.5
21 - 23	31	33	64	53.33
24 - 26	12	14	26	21.67
27 - 29	6	5	11	9.17
30 - 32	2	0	2	1.67
33 and above	1	0	1	0.83
Total	60	60	120	100.00

Mean intraocular tension right eyes $\pm$ S.D. = 22.983 $\pm$ 4.051 mm of Hg.

Mean intraocular tension left eyes $\pm$ S.D. = 22.266 $\pm$ 2.926 mm of Hg.

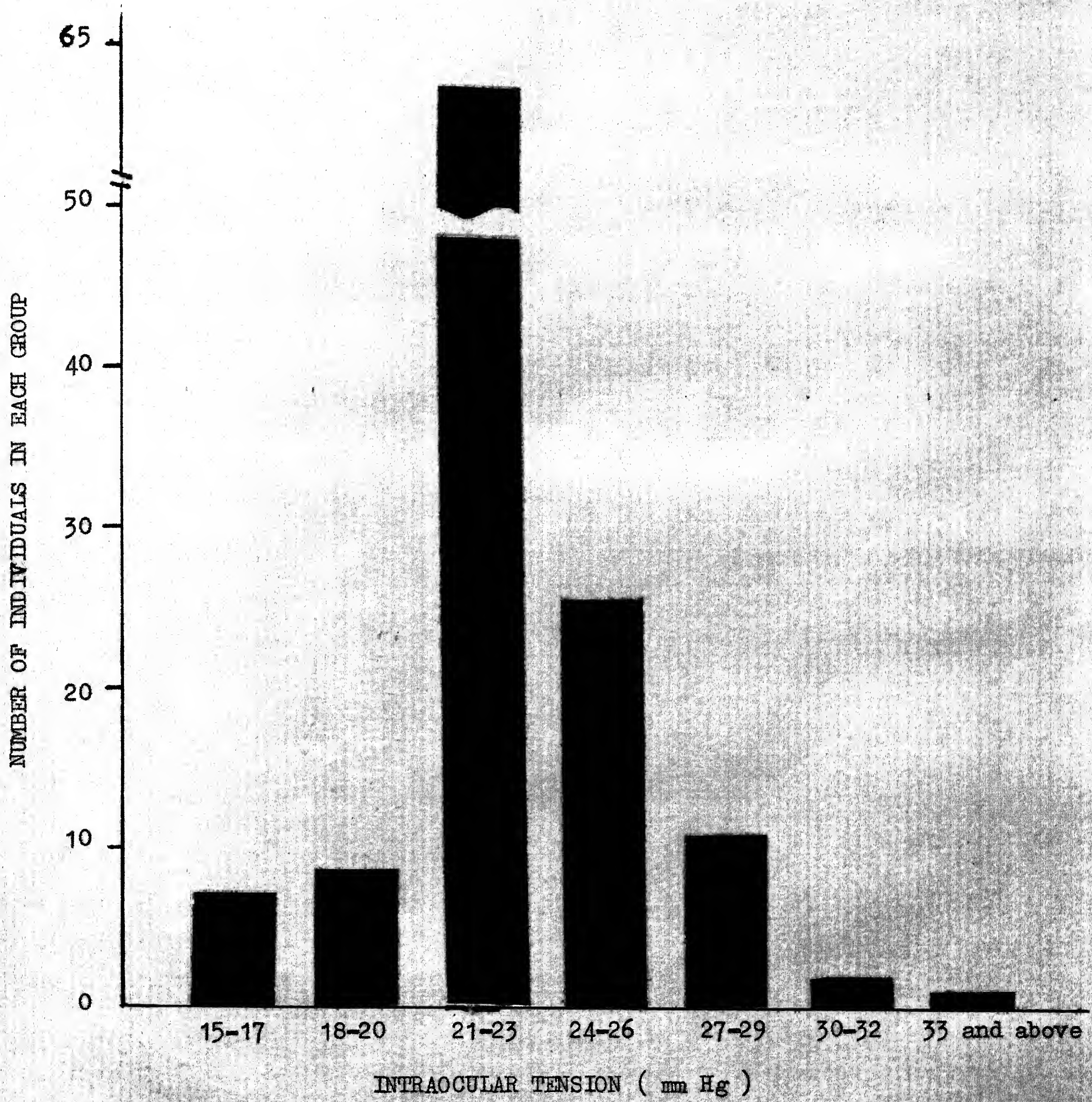


FIG - 12 DISTRIBUTION OF PATIENTS ACCORDING TO INTRAOCULAR TENSION.

Table 7 shows distribution of intraocular tension (Fig. 12). The maximum number of eyes (64) belonged to 21-23 mm Hg group, thus consisting 53.33% of total followed by 26 eyes (21.67%) in 24-26 mm of Hg group. There was no significant difference in mean tension of right and left eyes. The mean intraocular tension of right eye was 22.983 mm of Hg ± 4.051 as to left eye 22.266 mm of Hg ± 2.926 mm of Hg.

TABLE 8

FREQUENCY OF VARIOUS GRADES OF ANGLE OF ANTERIOR CHEMBER

Grades of angle	No.of eyes		Total	
	Right	Left	No.	%
Grade IV	26	26	52	43.33
Grade III	34	34	68	56.67
Grade II	-	-	-	-
Grade I	-	-	-	-
Total	60	60	120	100.00

Mean angle = 3.433

The above table indicates distribution of eyes according to angle grades. All the eyes had an open angle, 43.33% of eyes in Grade IV angle

and remaining 56.67% in Grade III angle. None of the eye had angle smaller than Grade III. Mean of angle was 3.433.

TABLE 9

DISTRIBUTION OF EYES BY DIAMETER OF PUPIL

Pupil Diameter in mm.	Right Eyes	Left Eyes	Total	
			No.	%
2 -2.4	2	2	4	03.33
2.5-2.9	9	9	18	15.00
3.0-3.4	26	19	45	37.50
3.5-3.9	19	25	44	36.67
4.0-4.5	4	5	9	07.50
Total	60	60	120	100.00

Mean pupil diameter ± S.D. = 4.085 ± 0.524 mm.

Pupil diameter varying from 2mm to 4.5 mm. was noted with maximum number of eyes falling in 3 to 4 mm. group. The mean pupil diameter was 4.085 mm. with standard deviation of ± 0.524 mm.

TABLE 10

CUP/DISC RATIO (NEAREST TO 0.1)

C/D Ratio	Right Eyes	Left Eyes	Total	
			No.	%
0. - 0.1	4	4	8	6.67
0.2 - 0.3	25	23	48	40.00
0.4 - 0.5	26	26	52	43.33
0.6 - 0.7	3	7	10	8.33
0.8 - 0.9	2	-	2	1.67
Total	60	60	120	100.00

Above table (Table-10) shows distribution of cases on the basis of cup/disc ratio. The most frequent C/D ratio group was 0.4 to 0.5 followed by 0.2 to 0.3, having 52 eyes (43.33%) and 48 eyes (40%) in each group respectively.

TABLE 11

FREQUENCY OF ROUND AND OVAL OPTIC CUPS

Shpae of cup	No. of Eyes		Total	
	Right	Left	No.	%
ROUND	31	30	61	50.83
OVAL	29	30	59	49.17
Total	60	60	120	100.00

Round as well as oval optic cups were seen almost in equal number of eyes. Out of 120 eyes examined 61 (50.83%) had round cups and the remaining 59 (44.17%) were with oval cups with no difference in right and left eyes.

TABLE 12

DISTRIBUTION OF CASES BY ASYMMETRY AND SYMMETRY OF TWO OPTIC CUPS

Cup	No. of Cases	%
Asymmetric	31	51.77
Symmetric	29	48.33
Total	60	100.00

The above table - 12 indicates number of cases with symmetric and asymmetric optic cups. 51.77% cases presented with asymmetry of two optic cups and in the remaining 48.33% cases the two cups were symmetric. (If cup/disc ratio of two eyes were not equal asymmetry of optic cups was said to be there).

TABLE 13

DISTRIBUTION OF FIELD DEFECTS

Field defect	Male	Female	Total	
			No.	%
Present	19	17	36	60.0
Absent	14	10	24	40.0
Total	33	27	60	100.0

As table - 13 indicates 36 patients were found to be having field defects while in 24 cases no field defect could be demonstrated.

TABLE 14

DISTRIBUTION OF VARIOUS TYPES OF FIELD DEFECTS

Type of field Defect	Total	Alone	With other
Nasal Step	12 (21.81)	9(16.36)	3
Temporal Step	3 (05.45)	3(5.45)	0
Enlarged Blind Spot	10 (18.18)	9(16.36)	1
Baring of Blind Spot	8 (14.54)	7(12.73)	1
Paracentral Scotoma	15 (27.27)	11(20.01)	4
Arcuate Scotoma	7 (12.73)	6(10.90)	1
Arcuate Scotoma extending to periphery	2 (3.64)	2(03.64)	0
Ceecocentral Scotoma	3 (5.45)	3(05.45)	0

Figure in parenthesis indicates percentage calculated on basis of eyes presenting with field defects. Above table (Table-14) shows frequencies of various types of field defects (Fig. 13). The most common field defect was paracentral scotoma (21.27%) followed by nasal step (21.81%), enlarged blind spot (18.18%) and baring of blind spot(14.54%). When we searched for lone defect, paracentral scotoma was seen in 20.0% cases, nasal step in 16.36% cases, enlarged blind spot in 16.36% cases and baring of blind spot in 12.73% cases.

TABLE 15

RELATIONSHIP BETWEEN C/D RATIO AND SHAPE OF THE CUP

C/D Ratio Shape of Cup	0-0.1	0.2-0.3	0.4-0.5	0.6-0.7	0.8-0.9
Round	8	39	14	0	0
Oval	0	9	38	10	2

$X^2 = 46.046$ DF 1 $P \angle 0.001$

(Comparing cases with C/D ratio 0.0 to 0.3 with cases having C/D ratio 0.4 to 0.9).

TABLE 16

RELATIONSHIP BETWEEN SHAPE OF CUP, INTRAOCULAR TENSION AND FIELD DEFECT

Shape of cup	I.O.P. 21 mm of Hg or more		I.O.P. $\angle$ 21mm of Hg	
	No.of Eyes with Field Defect		No.of Eyes with Field Defect	
	Present	Absent	Present	Absent
Oval*	42 (79.24)	11 (20.76)	2	4
Round*	11 (21.67)	40 (78.43)	0	10

*Figure in parenthesis indicate percentage.

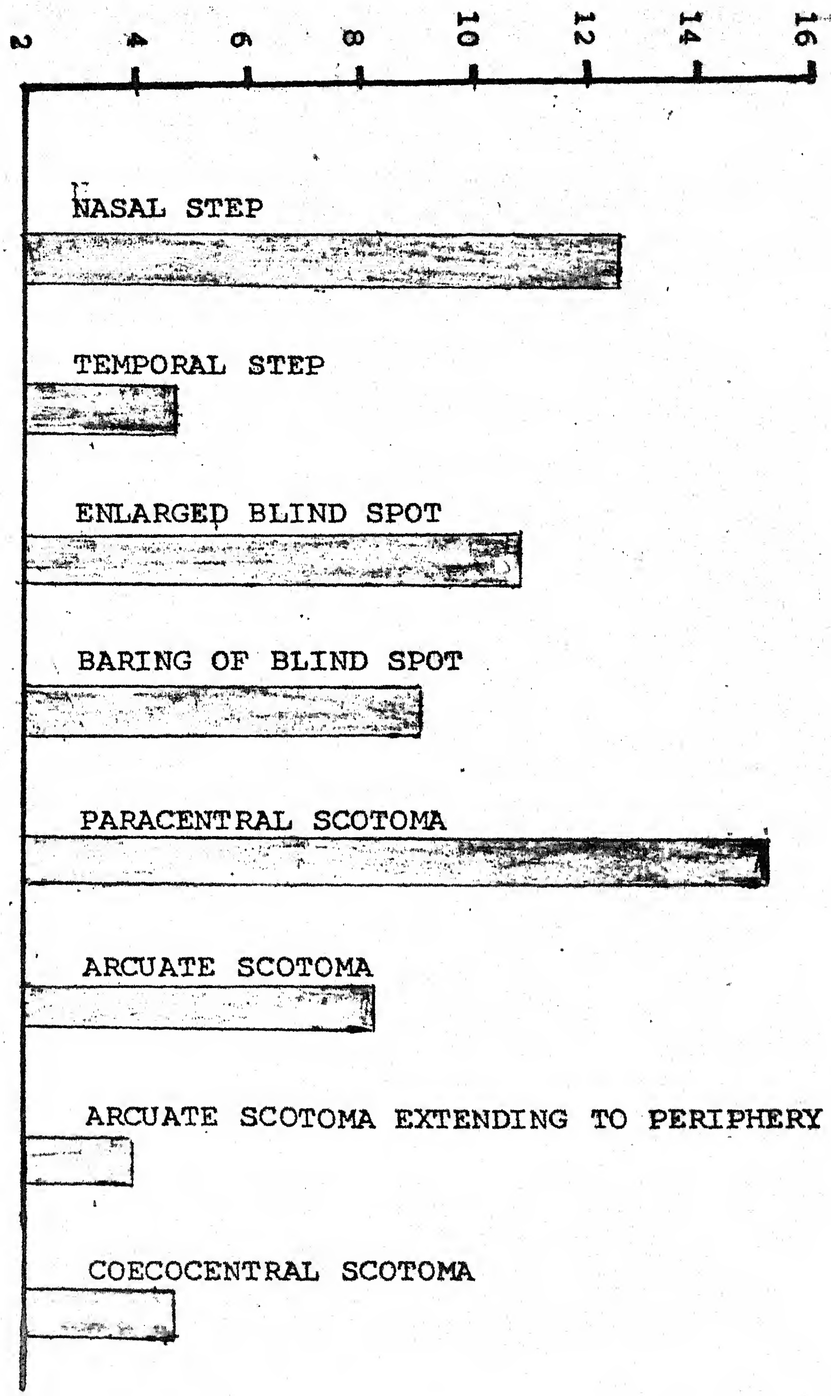
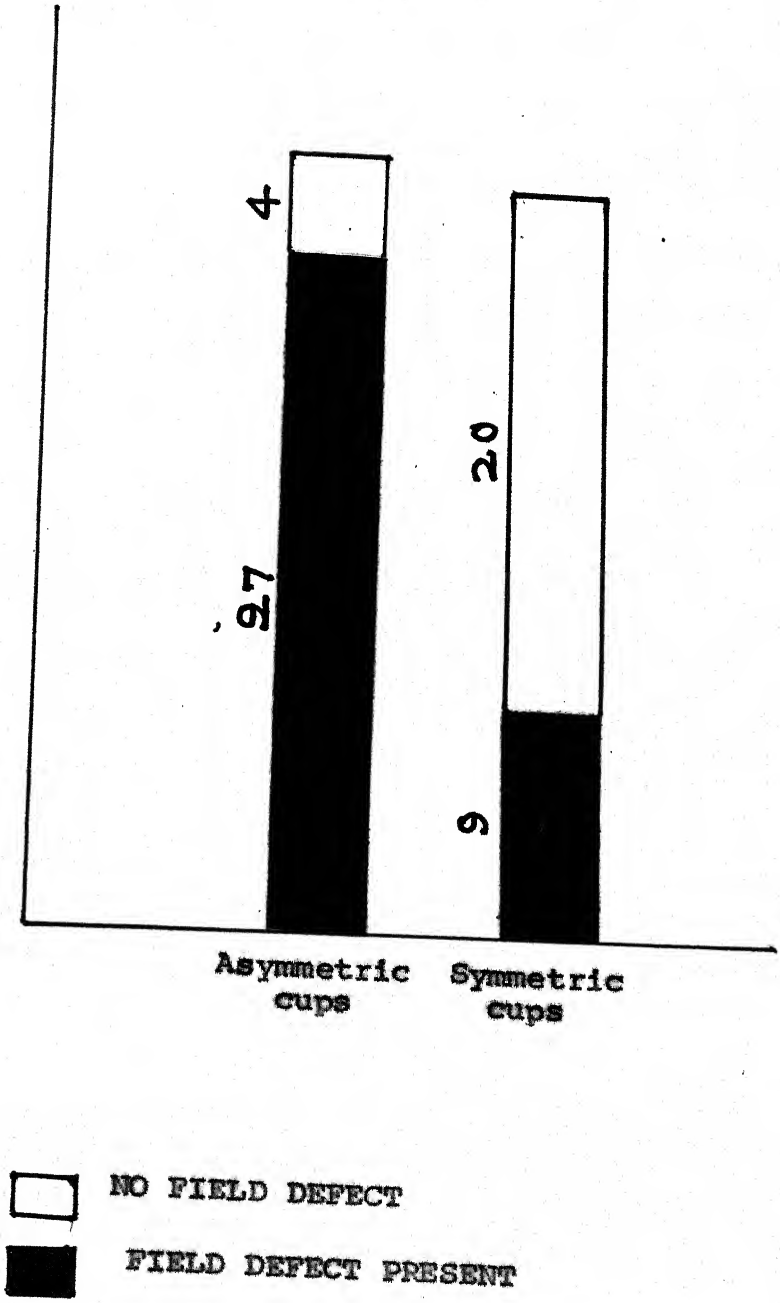


FIG - 13 DISTRIBUTION OF VARIOUS TYPE OF FIELD DEFECTS



- 14 RELATIONSHIP BETWEEN ASYMMETRY OF CUPS & FIELD DEFECTS

TABLE 17

RELATIONSHIP BETWEEN ASYMMETRY OF TWO CUPS AND FIELD DEFECTS

Shape of Cup	Field Defect			
	Present		Absent	
	No.	%	No.	%
Asymmetry of two optic cups (31)	27	75.00	4	16.67
Symmetric cups (29)	9	25.00	20	83.33
Total	36	100.00	24	100.00

X^2 = 19.62 DF 1 P = $\angle$ 0.001

The above given table 17 shows relationship between asymmetry of optic cups and field defects (Fig. 14).

From the total of 36 patients which presented with field defects, 27 patients (75.00%) had asymmetry of two optic cups. Four patients (25.00%) with asymmetry of two optic cups were not having field loss. These findings were statistically significant (X^2 = 19.62 P $\angle$ 0.001). In patients with no field defects 24 cases, 20 cases (83.33%) had symmetric optic cups while 4 cases (12.67%) had asymmetry of two optic cups.

TABLE 18

CORRELATION BETWEEN C/D RATIO AND INTRAOCULAR TENSION

I.O.P. (mm of Hg) C/D Ratio	15-18	18-21	21-24	24-27	27-30	30-33
0 -0.1	0	1	6	1	0	0
0.2-0.3	4	12	23	8	1	0
0.4-0.5	3	12	12	16	9	0
0.6-0.7	-	-	7	1	1	1
0.8-0.9	-	-	-	-	-	2

$r = + 0.3329$ $t = 3.631$ $P \angle 0.001$

Table 18 shows correlation between intraocular tension and C/D ratio. There was a significant positive correlation between the intraocular tension and C/D ratio ($r = + 0.3329$, $t = 3.631$, $P \angle 0.001$).

TABLE 19

DISTRIBUTION OF EYES ON BASIS OF C/D RATIO AND FIELD DEFECTS

C/D ratio	With field defects	Without field defects	Field defect		
			Bilateral	Unilateral	No defect in both eyes
	(1)	(2)	(3)	(4)	(5)
0-0.1	-	8(12.31)	-	-	8(16.66)
0.2-0.3	12(21.82)	36(55.38)	14(33.33)	10(33.33)	25(52.08)
0.4-0.5	31(56.36)	21(32.30)	21(50.00)	15(50.00)	15(31.25)
0.6-0.7	10(18.18)	-	5(11.90)	5(16.66)	-
0.8-0.9	2(3.64)	-	2(4.76)	-	-
Total	55	65	42	30	48

$X^2 = 25.2$ DF = 1 P $\angle$ 0.0005 (Comparing 1 and 2)

$X^2 = 11.25$ DF = 1 P $\angle$ 0.001 (Comparing 3 and 5)

Figure in parenthesis indicate percentage according to that group.

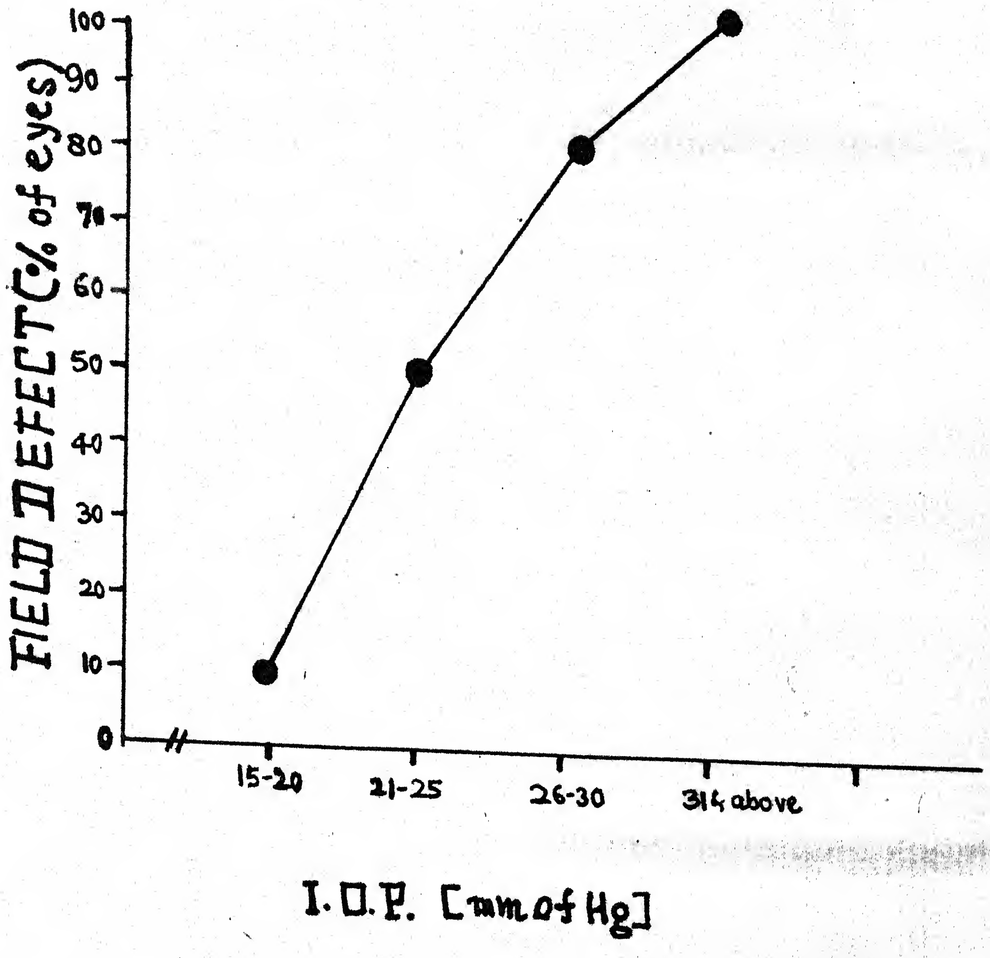


FIG. 15. RELATIONSHIP BETWEEN INTRAOCULAR TENSION & FIELD DEFECT.

Fig. 16 FUNDUS PHOTOGRAPH SHOWING LARGE CUP (C/D = 0.5) WITH NASAL SHIFT.

TABLE 20

RELATIONSHIP BETWEEN INTRAOCULAR TENSION AND PERCENTAGE FIELD DEFECTS

I.O.P. (mm Hg)	Total No. of eyes	Eyes with field defects	
		No.	%
15 - 20	32	6	9.37
21 - 25	67	31	50.00
26 - 30	18	15	83.25
31 - 35	3	3	100.00

$X^2 = 14.892$ DF 2 $P = 0.001$

(Comparing first 3 groups)

TABLE 21

SHOWING CORRELATION BETWEEN PUPIL SIZE AND TENSION

Tension(mm of Hg) Pupil Diameter (in mm)	15-18	19-22	23-26	27-30	31-38
2 - 2.5	1	9	9	8	3
3 - 3.5	10	37	34	3	0
4 - 4.5	0	6	0	0	0

$r = -0.1523$ $t = 2.2682$ $P < 0.05 > 0.02$

Table 21 shows correlation between pupil size and intraocular tension. Pupil size was found to be having weak negative correlation with the intraocular tension ($r = -0.1523$, $t = 2.2682$, $P < 0.05 > 0.02$).

D I S C U S S I O N

D I S C U S S I O N

The chronic simple glaucoma or glaucoma simplex is by no means simple, and diagnosis in the early stages may be rather elusive. Still the etiology of chronic simple glaucoma is very largely a matter of speculation in spite of the large volume of research work which has been done, over the last hundred years.

In view of poor understanding of etiopathogenesis of chronic simple glaucoma, attempts made at the early diagnosis of disease are quite frustating. Problem becomes more difficult because of the very slow course of disease process keeping patient ignorent about the actual damage. Although chronic simple glaucoma itself is never lethal yet great amount of morbidity is caused by it.

The diagnosis of glaucoma is not based upon a single parameter but it is always made on the basis of several parameters vis intraoculer tension, field defects, appearence of optic cup and disc etc. The knowledge of relationship of

these parameters will be useful addition to the present diagnostic armamentarium for chronic simple glaucoma. This study, therefore, has been an attempt to find out relationship between various ocular parameters and thus in turn to achieve an early diagnosis in glaucoma suspects.

Total 60 studied patients of either sex were classified according to their mode of presentation into 2 groups i.e. group I, group II (detail given earlier).

The group I had 50 cases (83.33%) and in group II consisted of 10 cases (16.67%). Thus the majority of cases were in group I which have a high risk as to eventual glaucomatous loss. Various workers have also noted the same, Linner and Stromberg (1967), Leydhecker (1967), and Kitazawa et al (1977).

The average age of the total patients was 45.66 years (S.D. ± 11.52) with a no significant difference between age of males and females. Mean age of males was 45.57 years as to 44.13 years of female. Thus these were the cases in which one can assume beginning of degenerative and sclerotic changes as also stated by Duke-Elder(1970).

He has also defined glaucoma as a disease of sclerosis and degenerative age group. Male/ female ratio was 1:0.818. Slightly higher number of males may be attributed to over-all more awareness of male population because of higher literacy status.

The chief presenting complaint in majority of cases was the diminution of vision (78.33). Almost all of these cases consulted for difficulty in near vision, however, on further investigations they were also found to have defective distant vision. Only 22.67 percent came with others complaints. After elimination of refractive errors, approximately all cases (96%) attained normal vision (6/9 or better in bad eye). Thus we can say, as such, chronic simple glaucoma is a symptomless disease in early stages, Elkington (1975) did have the similar view. All the 120 eyes had open angles as observed by Goldmann 3 mirror Gonioscope. The mean of angle was 3.433. Thus all these cases had non occludible angles.

104 eyes (86.67%) had intraocular tension of 21 mm of mercury or more while remaining 16 eyes (13.33%) were with intraocular tension of $\angle$ 21 mm

of mercury. These eyes were from both the groups. The mean intraocular tension of right eyes was 22.983 mm of Hg (SD $\pm$ 4.051) and that of left eyes was 22.266 mm of Hg (SD $\pm$ 2.926). This was significantly higher than the normal range of mean values. Mean values ranging from 14.0 mm of Hg to 18.0 mm of of Hg have been reported in normal population by various workers. Draeger (1959), 14.5 mm of Hg; Abrahmson and Abrahamson (1959), 18.0 mm of Hg; Levene (1961), 15.6 mm of Hg; Armaly (1962), 15.92 mm of Hg; Armaly and Salsumon (1963), 17.3 mm of Hg.

There was a strong positive relation between the intraocular pressure and presence of field defect. (X^2 = 14.892 DF 2 P $\angle$ 0.001) (Table 20). Increase in intraocular pressure was associated with a similar increase in percentage of eyes with field defect.

Thus despite the increasing accuracy and availability of other methods and the ultimate dependence upon perimetry, the early detection of glaucoma is still largely dependent upon routine tonometry. However, Schiotz determinations of

intraocular pressure may be wrong because of deviations from the assumed average value for scleral rigidity, but Goldmann applanation tonometry reveals the correct intraocular pressure thus in turn a and results in more accurate diagnosis.

The majority of eyes (89) were having pupil diameter in between 3.0 to 3.9 + with a mean pupil diameter of 4.085 mm (SD $\pm$ 0.524). This was within the normal range.

There was an increased frequency of large C/D ratio i.e. cup/disc ratio greater than 0.3 (Table 10). From the total of 120 eyes studied, 64 (53.33%) eyes had cup/disc ratio greater than 0.3. The eyes not having cup/disc ratio greater than 0.3 also showed a tendency towards the bigger cups and most of the eyes (40%) from this group had a cup/disc ratio 0.2 to 0.3 (Table 10). This tendency of shift to a larger C/D ratio may be because of the fact that the eyes taken into this study presented with a greater risk of developing glaucoma.

On comparing the C/D ration of affected eyes (either from cases with unilateral or bilateral involvement) with that of eyes with normal visual field,

we observed a statistically significant difference in cup/disc ratio of two groups (X^2 = 25.2 DF 1 $P \angle 0.005$). Most of the eyes (78.18%) with field defects had a C/D ratio greater than 0.3 with a maximum percentage of eyes (58.38%) belonging to C/D ratio group of 0.4 to 0.5 while majority of the eyes (67.71%) with no field defect were with a C/D ratio in between 0.0 to 0.3 (Table 19). When the cases with visual field involvement were compared with those of having normal visual fields in both the eyes, a statistically significant difference was found in frequency of C/D ratio in two groups (X^2 = 11.25, DF 1, $P \angle 0.001$) (Table 19). Thus these findings are in accordance with those of Armaly (1970), Fisher (1970) and Elkington (1975).

Equal numbers of oval (vertically) and round optic cups were seen (Table 11). On further analysis it was found that round cups were usually smaller in diameter as compared to oval cups. The cup/disc ratio of 77.05 percent of round optic cups was within 0.3 whereas, only 15.25 percent oval cups were in this group (Table 15). These findings were statistically significant (X^2 = 46.046, $P \angle 0.001$).

When we searched for presence of field loss, 82 percent eyes with round cups had normal fields while in case of oval cups 75 percent had field loss. This percentage of eyes with field defect increased to 79.24 percent when eyes with intraocular tension of more than 21 mm of Hg were taken into consideration (Table 16).

These findings clearly indicate that non glaucomatous cups are round while glaucomatous cups are vertically oval.

Many author assert the same view in their papers. Kirsch and Anderson (1973) (after examining 40 normal and 80 glaucomatous patients) emphasised the significance of vertically oval cup in early diagnosis of chronic simple glaucoma. Similar was the view of Weisman et al (1973), and Gloster (1975).

Although 21.67 percent of eyes with I.O.P. > 21 mm Hg had round optic cup yet field defects were seen (Table 16). These findings are not in accordance with Weisman et al (1973), Anderson (1973) and Gloster (1975). This difference could be due to the fact that though oval cups were there, but there presence could not be demonstrated by the methods used.

The more sophasticated examinations via Sterioscopic fundus photographs, projected transparencies etc. would have been able to detect the ovalness.

In 20.76 percent eyes with oval optic cups and raised intraocular tension, no field defects were seen. (Table 16). These may be considered as those cases of ocular hypertension, in which earliest change (change in cup) is evident but no field defect has appeared yet. Similar was the view of Fisher et al (1970). He stated that probably excavation of disc precedes the development of field defects.

In the individuals either with monoocular involvement or bilateral involvement of the visual fields (36 cases), the C/D ratio was larger in one eye than the other in 27 subjects. Thus on the basis of this inequality or asymmetry of two optic cups, we were able to suspect glaucoma in 75% of cases (Table 17). These findings were statistically significant ($X^2 = 19.62$, $P \angle 0.001$). Various workers have noted values ranging from 36% to 82%, Fishman (1970), 36% ; Armaly (1970) 69% and Sharma and Chaturvedi (1982) 82.8%.

In 4 cases (6.66%) asymmetry of optic cups was not associated with field defect. These casesmay be considered as normal ones. In normal population asymmetry of cups was also observed by various workers but to a very little extent. In a group of 500 patients, Syndachker (1964) found asymmetrical cups in 15 (3%) while Armaly and Saydegh (1969) noted asymmetry of two cups in 8% cases.

In the view of foregoing discussion it is clearly evident, that enlargement of the optic cup in open angle glaucoma is not limited to the later stages of the clinical disease but can be detected in the earlier stages, long before the individual becomes aware of this condition. Thus, careful ophthalmoscopic examination for asymmetry of two optic cups, becomes an important and useful tool in the suspicion and detection of this otherwise symptomless disease. Considering the simplicity of this procedure and the high frequency of false positive suspicion by tonometry alone, the clinical usefulness of ophthalmoscopy in early detection of chronic simple glaucoma becomes obvious. This is further emphasized by the innocuous nature of this examination.

It is also evident from the above description that asymmetry of two optic cups is a good indicator for detection of glaucoma. So we wish to advocate searching for asymmetry in glaucoma screening. Its presence, especially in an ocular hypertensive, should be of itself an adequate indication for further evaluation.

By Goldmann Kinetic perimetry field defects were found in 36 cases. Out of these 36 cases, 21 had bilateral involvement and 15 cases presented with unilateral involvement. Thus total of 55 eyes suffered from field loss. This relatively high frequency of field defects may be due to more biased population selection.

The most common field defect was the paracentral scotoma. This consisted of defects (at least 10° in diameter) affecting the 5°, 10° or 15° circles, with or without connection with the isopter or the blind spot as demonstrated by I/2e. 15 eyes (27.27%) presented with this defect. This type of defect was also confirmed by the central field charting using Bjerrum tangent screen. In 11 eyes (20%) this was the only defect while in 4 eyes, this was associated with some other defects. Thus

in 20% cases with the presence of paracentral scotoma, one could have suspected and diagnosed glaucoma by Goldmann perimetry. These findings attest the view of Von Graefe (1869), Traquair (1939), Aulhorn and Harms (1967), Drance (1969). They have also reported paracentral scotoma as an early field defects.

The next most frequent defect was the presence of nasal step. This was detected by I/2e and in few cases with I/4e. This consisted of nasal step greater than five degrees at isopter boundary, nasal step within isopter boundary or nasal step continuous with blind spot. Twelve eyes (21.81%) presented with nasal steps. Out of which 9 eyes (16.36%) had nasal steps as a lone defect, akin to Le Blanc and Becker (1971) who noticed peripheral nasal field defects with step like features in 20% eyes suffering with open angle glaucoma. Newell (1969), Armaly (1971) and Harrington (1971) have also stressed the presence of nasal step as an early field defect.

Similar was the view of Zingirian (1979). After examining the nasal visual field of normal and

glaucoma suspects he concluded that nasal step wider than 4° and with a depth of greater than 0.5 log unit is a characteristic glaucomatous field defect.

So, we wish to recommend the use of Goldmann Kinetic perimetry for detection of nasal step which can be used as a sensitive marker in early diagnosis of glaucoma.

The various other field defects found were enlargement of blind spot (10 eyes), baring of blind spot (8 eyes), Arcuate scotoma (7 eyes), arcuate scotoma extending to periphery (2 eyes) and coecocentral scotoma (3 eyes).

The enlargement and also baring of blind spot was recorded on tangent screen with 1/2000or 2/2000 and by Goldmann perimeter using I/2e target. But these can not be considered as an early glaucomatous field defect, although stated by Bjerrum (1889), Ronne (1901) and Pollak (1967) because the size of blind spot varies markedly with the stimulus value so that the general limits for the normal blind spot can not be developed. Such reduction in stimulus value, as its arrives onto the retinal surface, can be easily produced by

change in lens with age or transmissivity of the entire optical pathway. So that if we project the I/2e on the perimeter bowl we will actually have an 1/2a value on the retina and the elongated or bared blind spot thus obtained, will be incorrectly considered glaucomatous in character. Armaly (1969) also has the similar view. The fact that these ocular changes are not of uncommon occurence after the age of 40 years, markedly reduces the clinical significance of an enlarged, enlongated, or bared blind spot.

So we can say that these changes, infact, preclude their use as criteria of the glaucomatous effect of visual function which are to be used in justifying the transition from the stage of suspicion to that of definite diagnosis. By this we may not intended to say that such defects may not also be due to a reduction in the sensitivity of these retinal areas by glaucomatous process. It does mean, however, that non glaucomatous factors of far greater frequency than the disease process produce identical changes and in doing so, markedly reduce their presumed value and destroy their usefulness in establishing the diagnosis of glaucoma.

The various others remaining field defect viz arcuate scotoma (7 eyes), arcuate scotoma extending to periphery (2 eyes) & caecocentral scotoma (3 eyes) cannot be considered as early defects as they were usually seen in those eyes in which diagnosis of glaucoma was not in question. So we can clearly say that early field defects in chronic simple glaucoma as observed in our series were paracentral scotoma and nasal step.

Thus we would like to advocate visual field examination by Goldmann perimeter for search of paracentral scotomas and nasal step in early diagnosis of glaucoma. The reproducibility and reliability of visual fields examined by Goldmann perimeter places it at the top. So visual field examination by it becomes a cornerstone in early diagnosis of glaucoma.

Two cases of unilateral glaucoma presented with Gunn pupil. This was a relatively new finding. Only few workers have noted it (Kaback et al, 1976; Prywes, 1976).

In the present study the size of pupil was shown to have a poor negative correlation with intraocular pressure ($r = -0.1523$, $0.05 > P < 0$). At the first instance this seems to be quite an alarming finding because we are only aware of dilated pupil in cases of glaucoma. But this mydriasis is only seen in cases with very high intraocular pressure (Charles and Hamasaki, 1970; Rutkowski & Thompson, 1972). As the predominant role of parasympathetic tonus in miosis is known and the fact that the parasympathetic tonus increases with an increase in intraocular pressure, the relationship between pupil size and I.O.P. becomes self explainatory. This observation do, however, support the view of Fisher et al (1970). They have found a significant negative correlation between size of pupil and intraocular pressure ($r = -0.409$, $P < 0.01$).

CONCLUSIONS

CONCLUSIONS

The present study conducted in the Department of Ophthalmology at M.L.B. Medical College and Hospital, Jhansi for early diagnosis of chronic simple glaucoma in glaucoma suspects by various ocular parameters, leads to the following conclusions :

1. Chronic simple glaucoma is a disease of late forties and fifties years of age. The fact being that vascular sclerosis and degenerative changes starts at this age.

2. In early stages of chronic simple glaucoma, a very little number of patients present with complaints pertaining to glaucoma. In majority of cases the main presenting complaint remains difficulty in near work.

3. A positive relationship exits between intraocular tension and presence of field defects.

Thus routine Goldmann applanation tonometry is indispensible in early detection of chronic simple glaucoma. Its high yield as

compared to Schiotz replaces the use of letter in glaucoma screening.

4. Glaucoma suspects usually have more frequent large C/D ratio than normal limits (53.33% incidence) and eyes with C/D ratio larger than 0.3 usually have field defects (78.18% incidence).

5. A statistically significant relationship exists between the shape of cup and its size. Optic cup smaller than 0.3 disc diameter being round and bigger than this being oval in shape.

6. Eyes with oval cups usually show visual field defects (75% incidence).

7. Asymmetry of two optic cups is a good indicator for diagnosis of chronic simple glaucoma.

8. The most common early field defect (27.27%) is paracentral scotoma within the central 30°. Which is best demonstrated by Goldmann perimeter using I/2e and occasionally I/1e target.

9. Nasal step (21.81%) comes second as an early field defect seen by Goldmann perimeter using I/2e or I/4e target.

10. Temporal step (5.45%) can also be present as an early field defect in few cases.

11. Arcuate scotoma, arcuate scotoma extending to periphery and coecocentral scotoma are the field defects of established cases.

12. Baring of blind spot and enlargement of blind spot can not be considered as early field defects because of their inconsistent nature.

13. Unilateral glaucoma can some times presents with Gunn pupil. So presence of Gunn pupil should be kept in mind as a logical possibility in glaucoma cases.

14. Pupil size as such does not show any significant change in early stages of glaucoma.

15. Pupil size has a weak negative correlation ($p < 0.05 > 0.02$) with the intraocular tension. The increase parasympathetic tonus due to raised intraocular tension thus in turn causing miosis is considered as a suitable explanation.

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APPENDIX

"EARLY DIAGNOSIS OF CHRONIC SIMPLE GLAUCOMA BY VARIOUS DIAGNOSTIC OCULAR PARAMETERS".

PROFORMA FOR EXAMINATION

Case No.	Name
Name of investigator	Age
Surgeon I/C	Indoor/Outdoor No.
Place of work	Address
Date	

---

1. Presenting complaints

    1.

    2.

    3.

    4.

2. Brief History

    1. Diminition of vision Yes/No
       If yes

        1. Transient/Permanent

        2. Distant/Near

        3. In low illumination/
           in adequate illumination

        4. Rapid/ Slow

        5. If any recent change of glasses.

    2. Eyeach Yes/No
       If yes

        1. Time of onset
        2. Transient/Intermittent
        3. Mild/Moderate/Severe

3. Regarding visual fields Yes/No
   If yes

   - Black spots infront of eyes
   - Mist infront of eyes 1. Recent/Past
   - Difficulty in driving

4. Headach Yes/No

   1. Side
   2. Time of onset
   3. Duration
   4. Factors affecting

5. Any other symptoms

Personal History

(a) Occupation Hard worker/Active/Sedentory.

(b) Diet Veg./Non Veg./Frequent non veg.

(c) Addiction Tobacco/Alcohol/Drugs.

Past History

(1) Diabetes Yes/No

(2) Hypertension

(3) Cardiovascular disorders

Family History

(1) Glaucoma

(2) Any other eye disease

CLINICAL EXAMINATION

(1) Built
(2) Mental Status
(3) B.P.
(4) Pulse

Systemic examination

(1) Respiratory

(2) C.V.S.

(3) G.I.T.

(4) C.N.S.

Local examination Right eye Left eye

(1) Facial symmetry

(2) Orbit

(3) Eye lids - Upper

- Lower

(4) Conjunctival congestion

(a) Palpebral

(b) Bulbar

(c) Limbal

(5) Cornea

1. Size

2. Shape

3. Surface

4. Sensitivity

(6) Anterior chamber

1. Depth of A/C

2. Contents

IRIS

- Colour

- Pattern

- Iris atrophy

Pupil

- Size
- Shape
- Margins
- Colour
- Reaction
    - (a) To light - Direct
        - Consensual
    - (b) To accomodation

Lens

- Transparency

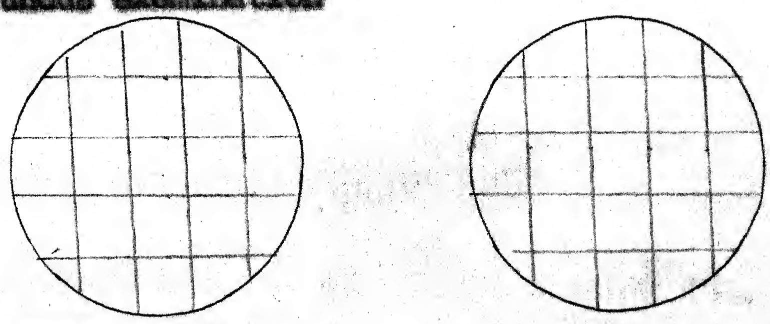
Special Investigations

1. Visual acuity
    - (a) Distant - Uncorrected
        - Corrected
    - (b) Near - Uncorrected
        - Corrected

2. Tension Random
    (By applanation)

3. Gonioscopy
    Angle of A/C
    Grade I. (Close)
    II.
    III.
    IV. (Open)

4. Fundus examination



5. **Visual fields**
    - (a) Peripheral
    - (b) Central